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INVESTIGATIONS ON THE PLAICE

GENERAL REPORT

BY

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I. THE PLAICE FISHERY AND PROTECTIVE REGULATIONS

FIRST PART

WITH 27 FIGURES IN THE TEXT, 1 CHART, 4 PLATES AND 27 TABLES

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INTRODUCTION.

THE plaice and haddock are the two food-fishes of the North Sea, which are caught by the trawl-fisheries in greater quantities than any other species of fish. Judged by weight these two fishes alone contribute at the present time about 60 per cent of the total, annual product of the trawl-fisheries of the North Sea; three fourths of this amount (45 %) is the share of the haddock and one-fourth (15 %) that of the plaice. In regard to weight, certainly, the cod is almost equal to the plaice, contributing likewise about 15 % of the product of the trawl-fisheries, but in number of individuals this species is far behind the plaice. Judging by value, the catch of haddock and plaice in the North Sea, taken together, may be estimated at about 50—55 %, thus a little more than half the value of all fish captured by the trawl; to this sum the haddock contributes about three-fifths, the plaice two-fifths (1)[1].

In great contrast to the plankton-eating herring, which lives free in the water, and to the predatory cod, which wanders about in all layers, the plaice and haddock are peaceful fishes which live directly on the bottom and feed almost exclusively on the small, little-moving animals of the sea-bottom, as mussels, worms and sea-urchins. They are the true and typical herding and grazing fish of the North Sea, which convert the rich store of lower animal-life in this region into fish-food and make it available to man, in the same way as the herring redistributes the plankton of the upper, free layers of water.

When we consider the outstanding importance of the haddock and plaice for the North Sea fisheries, owing to the enormous numbers which occur and are captured, and when we remember also that by far the greater proportion is caught by the trawl (to about 90 % of the weight), it is not difficult to understand, why the question of overfishing in the North Sea should just be connected in the first place with these two species.

"*Overfishing*" may be understood in different ways: permanent decrease in the total, annual quantities of a given species under constant or increasing intensity of fishing; permanent decrease in the absolute quantity of the large, old individuals of a species; permanent increase in the relative quantities of the small, young fish of a

[1] This and the subsequent bracketed numbers in the text refer to the literature (sources) in the appendix to this Report.

species, by comparison with the number of larger and older. In any case it is well-known, that these signs of a possible overfishing in the North Sea were first observed about the middle of the last century, when steam-power entered into the service of the sea-fisheries, and more particularly in the middle of the nineties, when the otter-trawl gradually replaced the older beam-trawl and the number and size of steam-trawlers increased at the same time to such a great extent. At this period, simultaneously with the enormous increase in the product of the trawl-fishery, complaints began with regard to the ruinous and uneconomical methods of this fishery and they always referred, almost exclusively, to the plaice and haddock. These complaints culminated in the belief, that the trawl-fishery in its present extension and form captures enormous quantities of young, immature haddock and plaice, the destruction of which means lasting damage to the maintenance of the fish-stock of the North Sea.

Whilst the question of overfishing in the North Sea only concerns practically the haddock and plaice at the present time, it is yet of far more importance in connection with the latter species, in so far especially as the destruction of large quantities of young, immature fish is concerned. The reason for this lies undoubtedly in the fact, that the plaice is remarkably different from the haddock, in regard to both its distribution in the North Sea and the occurrence of its various stages. The true home, above all the spawning and birth-places of the haddock and its principal resort in the first years of its life, lies in the larger and deeper, northern North Sea. The plaice, on the other hand, is in the main a fish of the more restricted and shallower, southern and eastern parts of the North Sea out to a depth of 60 m., approximately south of a line drawn from Flamborough Head to the Skaw.

Of the ca. 50 million kilogrammes or about 200 millions of plaice, which are landed yearly from the North Sea, over 90 % come from this southern region (2). Here we find the principal spawning-grounds of the plaice and here also, in the coastal zone from 0 to 40 m., the true young-fish grounds where the first three to four year-groups, that is, the young immature plaice of 2 to 25 cm. in length, live directly on and in the ground and collect together in certain months and at certain places in great quantities, with a probable density sometimes of from 20,000 to 60,000 per square kilometre (3). This southern and eastern part may with right be called the *plaice region* of the North Sea. As the intensity of the trawl-fishery, that is, the degree or amount of fishing in relation to the surface fished over, is here specially high, higher than in the northern North Sea, we see at once, that the stock of plaice in the North Sea must be affected by the ground-fishing to an extraordinary degree and that, above all, enormous quantities of young, immature plaice must be caught in the trawl and destroyed, especially within the shallow, coastal region out to 40 metres deep. So far as these young, still immature plaice which are caught in the trawl, are brought to market, they form there the principal component of the market-class known as "small", with an average length of 23—25 cm. and an average weight of 120 to 160 gm. These "small" plaice compose more than half the total weight of all plaice taken in the shallow, coastal zone, even up to 85 % in the 40 m. deep area of the German Bight of the North Sea (4). The smallest of these "small" plaice brought to market measure mostly 18 m. It can be readily shown also, just as it is well-known to all trawl-fishermen, that in addition to these small plaice which are brought

to market, a very large quantity of still smaller plaice measuring less than 18 cm. are caught in the coastal regions, especially on the true young-fish grounds, but are not landed. After capture these are simply thrown overboard again, as they can fetch no price on the market or because the landing of such small fish is forbidden by law, e. g. in Denmark and Germany. In the spring and summer months, at the time of the most intensive plaice fishery, the quantities of these young plaice, which are almost without exception dead when thrown overboard and thus quite uselessly destroyed, can be shown to be at least just as great in number, in most cases even twice to four times as great as the number selected as saleable from the catch (5).

This fact alone, that such a large quantity, counting many millions of young plaice still in the state of immaturity, is yearly destroyed in the North Sea, absolutely without any or with very little use to the fishery, must give rise to serious reflection and consideration. It brings us near to the fear, that such a ruinous method of fishing must in the end have a serious, detrimental influence on the maintenance of the plaice stock in the North Sea. It has perhaps come so far already, that the fishery is annually taking not only the highest possible interest of plaice-food, produced by the natural productivity of the sea, from the capital represented by the stock of plaice, *but is also attacking this very capital.* I say, perhaps matters have come so far. We do not know the extent of the capital, that is, the amount and composition of the stock of plaice, but only the amount of the yearly exploitation of this capital, that is to say, the quantity of plaice taken yearly, and even this only approximately. Nor do we know, how high we must estimate the productivity of the North Sea in regard to plaice-food, nor whether it is large enough, for example, to yield an annual rate of interest of 10, 20, 30, or even 50 % without reduction of the capital. It is very difficult, therefore, if not quite impossible, to say whether the plaice fishery is even now merely living on the interest of the capital or has already made inroads into the capital. Certain very noteworthy indications are nevertheless present, that the plaice stock of the North Sea, though perhaps remaining unchanged in weight, no longer has the same composition in regard to individuals which it possessed before the beginning of the intensive fishing by steam-trawlers, that is, about 30 years ago. It may be taken as certain, that the large and old plaice, of about 50 cm. in length and 9 to 30 years old, have considerably decreased in numbers relatively, that is, in proportion to the smaller plaice, and as probable, that their absolute quantity has also become reduced (6). The number of plaice taken yearly from the North Sea can be shown, in the first instance, to have very greatly increased after the beginning of the intensive trawl-fishery; since, now, the trawl, and particularly the otter-trawl, takes the small plaice from a certain size onwards equally well with the large plaice up to the greatest length, a decrease of the larger fish, owing to their smaller number absolutely, would very probably occur sooner than a reduction in the number of the small, the more so, as these large plaice grow very slowly. Their persecution must in fact be so severe, that no time is permitted them to reach the same great age as formerly. On the other hand, it may be considered as certain, that the quantity taken of young plaice, which are known under the trade-category of *"small"*, is even greater at the present time than earlier, when the steam-trawlers began their activity, both absolutely and relatively in proportion to the large. It is undoubtedly the fact namely, that, if the absolute

quantity by weight of plaice taken from the North Sea, for example in the last 10 years, apart from minor fluctuations, has remained the same, perhaps even increased somewhat, this has to be ascribed to the greater catch of small plaice alone, whilst the large plaice have decreased. This means, in other words; in earlier years, before the beginning of the intensive fishery with steam-trawlers, the sailing-vessels made a rich living from the capture of the large plaice, which were then in much greater quantities, and did not find it necessary to fish on grounds where the small plaice mainly occurred. At the present time, however, since the stock of large plaice has gradually become reduced, the trawlers have been obliged, in order to make ends meet, to bring in also the smaller plaice which had formerly been despised to the extent, that the young-fish grounds were avoided as unprofitable. And this means further, that after the large plaice were exposed to a greater persecution than before, owing to the increasing trawl-fishery, and in consequence decreased in quantity, an ever-increasing persecution of the small plaice has now begun. Whether this will also lead in the end to a reduction of the stock of small plaice in the North Sea, we are unable to say at present with certainty, but we may perhaps with some right regard it as probable. If this should really take place, it would mean a permanent and absolute reduction in the plaice stock of the North Sea, within the lengths of about 12 to 70 cm. The remaining stock of quite small plaice below 12 cm., at present still spared by the fishery, would then be required by itself to make good this reduction. Whether the last is possible, is a very difficult question, which cannot at present be answered. It is certain, however, that a reduction of the plaice stock, namely, a decrease in the numbers of old, large plaice, which is already the consequence of the fishery, can by no means lead to a constant replacement of the quantities removed. *A diminution in the numbers of the large, old plaice,* which are almost exclusively females and without exception fertile, means also a constant *reduction in the number of eggs spawned yearly* and thus also, other conditions remaining the same, a reduction in the increment of young, small plaice of the first two years (about 6 to 12 cm. on an average in length), which alone have not as yet been directly damaged by the trawl-fishery.

If we are thus still unable to prove that an overfishing has occurred, in the sense of an actual diminution in the total stock of plaice in the North Sea, yet certain changes in the composition of this stock, which are to be regarded as the consequence of the intensive trawl-fishery, can be recognized, namely, the great decrease in the number of large plaice and the still greater, absolute and relative increase in the quantities of small plaice in the catches. These make it seem possible, in fact, that an overfishing in the above sense has already really occurred, though we are unable to prove it, and that we are already wasting the capital, without knowing it. The fear of an already existing or impending overfishing seems, therefore, perfectly legitimate and justifiable to any one who knows the indiscriminate, not to say destructive character of the fishery with steam-trawls. *To deny this danger is to close the eyes intentionally.* But even those who do this in the belief, that the sea is so rich and so inexhaustible in its resources, that it can bear the severest possible fishing without permanent damage to the fish stock, must yet acknowledge, on general economical principles, that it is extremely harmful and serious, that millions of quite small and immature plaice of very little or no value are annually destroyed by the trawl-fishery on the young-fish grounds

of the North Sea; the fishes, which if protected and allowed to grow a few years longer, would possess a considerable value on the market.

This is briefly the *plaice question* and it leads naturally to the question of the possibility of a *remedy*.

Every remedy, whether it be in general against a too severe fishing, which may do permanent damage to the plaice stock, or merely against reckless and uneconomical destruction of immature plaice, is directed towards the fishing of fewer plaice than before, thus towards protecting a certain number of plaice. It is thus *a protective measure*. For a long series of years and in almost every country round the North Sea the question of the best, most effective and most practicable kind of protective measure has been most actively discussed by those interested in the fisheries, as well as by the Governments and their advisers. As most have been of the opinion, that the kernel of the evil which must be remedied, lay in the steam-trawl fishery, and especially in its newest form of the otter-trawl fishery, the protective measure that came first and foremost into the foreground was *a restriction of this trawl-fishery in the plaice region of the North Sea*. This may be attained in two ways; in the simplest and most thorough manner by the prohibition of the trawl-fishery in the whole plaice region or only in certain parts of this, for example, on the spawning grounds and the young-fish grounds of the plaice, or only at certain times ot the year; indirectly, but more uncertain in its effects, by the prohibition of certains forms of the trawl, for example, the otter-trawl, or by the legislative enforcement of larger meshes in the cod-end of the net, which might permit the small plaice caught in the net to escape from it uninjured. The general restrictions on the extent of the trawl-fishery might be without doubt the most effective measures, since they protect the fish before they are captured or at least whilst they are still in the water. But these are measures which, at the same time, so far as they are at all practicable, greatly restrict the freedom of the fishing industry and which possibly, seeing that they protect all fish and not only the plaice, might do more harm than good when introduced at the wrong time. Further, the control necessary for the carrying out of these measures would be very difficult. Essentially different from these *general* restrictions on the trawl-fishery are the regulations which would restrict the fishing of certain, definite species, either by forbidding their capture altogether or by forbidding the capture of certain sizes below a definite length *(size-limit)*. These so-called *individual*, protective measures are well-known and of great importance in the fresh-water fisheries, and appear to be very useful and effective there. Their principal advantage over the *general*, protective measures lies in the fact, that they can be carried into effect with comparative ease and controlled with certainty by the officials of the fish-market. A further advantage is, especially in the case of the sea-fisheries, that the freedom of the fishing industry is in no way limited; the product of the fishing is merely reduced by just so much as the forbidden fish represent on the market. Against this advantage, however, we have considerable disadvantages, especially in the sea-fisheries. Such prohibitions against the capture of a species below a certain size do not by any means give a guarantee, that these sizes are really protected. A restrictive size-limit for the plaice of about 18 cm. in length, such as exists for example in Germany, can practically never mean, that plaice below this size will not be captured — since the mode of trawling makes this impossible — but merely,

that plaice below this size may not be landed and sold. As a matter of fact also, millions of young plaice below 18 cm. in length are caught in the trawl. As these are below the size-limit, they are of no value to the fisherman and are simply thrown into the sea again. The intention of protective legislation is however only realized, if the undersized plaice which are caught and returned to the sea *can still live*. As a matter of fact, this is not the case or only to a very small extent the case with the catches of the steam-trawlers and most of those of the sailing-trawlers. The institution of a size-limit as a protective measure would thus be practically useless, unless it can have the effect indirectly, that the undersized fish are not caught at all or caught in the living condition, in other words, that it leads the fisherman to limit his fishing in his own interest and thus voluntarily. This is possible if the fisherman knows that on certain fishing-grounds and at certain seasons of the year, for example, on the young-fish grounds in the German Bight in the summer-time, the expected catch will consist of such a large percentage of undersized fish, that the fishing at such places will not repay him, but merely lead to a loss of time and labour. He will then certainly avoid such places. It is evident, that the extent or degree of protection afforded by such a size-limit depends essentially on the height of the limit; the higher this is, the more certain will be the desired effect.

Every protective regulation, whatever its nature may be, means in the first instance a reduction in the yield of the fishery, a definite loss, which will be all the greater according to the severity of the restriction, and, in the case of a size-limit, the higher this is. The capital locked up in the fishing industry will yield less interest. To make good this loss, the fisherman must either cheapen the cost of his industry or raise the price of his wares and thus transfer the loss to the consumer. Or he must seek for other fishing-grounds, on which, in spite of all protective measures, he can still make profitable catches. As the larger fishing companies, which work with large capital, will be most easily able, as a rule, to reduce their expenses and to seek for new, though mostly distant fishing-grounds or to change over to other, more productive forms of the industry, it follows that the loss which the fishery suffers directly through protective legislation, will fall relatively most severely on the small, independent and separate industries, above all the coastal and sailing fisheries, possibly indeed so heavily, that their persistence in the competition with the deep-sea steam-trawlers may be seriously jeopardized. This applies especially to the plaice fishery in the coastal regions of the southern and eastern North Sea, where at the present time a large number of the smaller Dutch, German and Danish sailing-vessels still make a profitable living.

The legislator will therefore scarcely agree to any incisive measure of protection, unless he is convinced, (1) that such a measure is absolutely necessary, in order to prevent imminent and permanent harm to the fish-stock and in order to make the senseless and purposeless destruction of the increment of young fish impossible, (2) that it is practicable and controllable and will really achieve the desired protection, (3) that the immediate, unavoidable loss to the fishermen will in the long run be converted into a real and permanent gain.

This is the question of protective measures for the plaice. It is not less actual and not less difficult of solution than the more abstract plaice question dealt with in

the beginning of this section, that is, the question whether an overfishing of the plaice stock of the North Sea has already set in or is imminent.

The brief discussion given above of the principal points in these two questions may serve as sufficient explanation of the following.

(1), *The solution of these questions is only possible by means of scientific investigations on the biology of the plaice and the fishery statistics.* Until we know in some measure precisely the general conditions for the nourishment, growth and reproduction of the plaice, until we have become more acquainted with its distribution and the composition of its stock, in size and age, and the inner changes in this stock through local displacement (migrations) in the North Sea and neighbouring waters, until we can state positively and accurately, how great are the quantities of plaice which are taken yearly by the fishery from the North Sea and how these quantities are composed in place and time and so on, until we have this information, we shall not be in a position to determine, whether the phenomena observed in connection with the plaice fishery are indications of a real overfishing or not, nor shall we be able with good reason to bring forward any measure whatsoever for the protection of the plaice stock, for example, a suitable size-limit, or foresee its possible effects.

(2). *Both questions are international questions,* which can only be solved by the combined work of the countries bordering on the North Sea.

(3). *Effective measures of protection can only be introduced by international agreement.* Owing to the international character of the North Sea outside the territorial, three-mile limit and owing to the great extension and mobility of the modern methods of fishing, the introduction of a definite size-limit, i. e. a prohibition practically against landing plaice under a certain size, by one or several States alone would not lead to any true protection, since the undersized plaice captured, though they could not be landed in the one country, e. g. Denmark, might unhindered be placed on the market in a neighbouring country, e. g. Germany.

It was reserved for the International Investigations to procure the first serviceable basis, on which the solution of the plaice question can be seriously considered.

The *international cooperation for the study of the sea* was founded in the belief, that a rational exploitation of the sea should rest as far as possible on a scientific basis and that one of the main aims of the work should be the practical advancement of the fishing industry (7). It requires no further explanation to see, that one of the principals tasks must be the scientific study of the overfishing question and of the possible protective measures, especially in connection with the plaice of the North Sea. The 1901 Christiania programme of the international investigations (8) bound the participating States to quite a series of investigations connected with these questions. In the biological part of the programme, §§ 2 and 3 prescribed the exact investigation of the distribution of the principal food-fishes, in the first instance the plaice, in all their different stages by means of scientific experiments, as also the biology of these food-fishes; §§ 10 and 11 refer to the question of the destruction of immature (undersized) fish and call for an exact determination and investigation of the so-called young-

fish grounds by means of experimental fishing, as also for a determination of the relative and absolute amount and composition of the catches of immature fish landed by the different fisheries in the larger fishing-ports. § 20, lastly, brings forward the extremely important point, the necessity of obtaining useful, scientific *statistics* regarding the sea-fisheries of all the participating countries, according to species, place of capture, time of capture, number and weight of the fish.

When the international investigations received a definite constitution, at the beginning of the cooperative work in 1902, the question of overfishing in the North Sea, with especial regard for the plaice, was put forward as one of the principal points to be investigated and a special Committee (the earlier Committee B) with Dr. GARSTANG as Convener was appointed to deal with it.

This Committee at once took up the work, especially in connection with the plaice; investigations were first made on the general biology of the plaice and in particular on its distribution in the different parts of the North Sea, according to size, age, sex and density of the occurrence by number and weight, all by means of scientific fishery-experiments, which were carried out by the research-steamers in the service of the international investigations. The work published a short time previously by REIBISCH of Kiel (9), which showed the possibility of determining the age of a plaice with great certainty by means of the so-called annual rings on the otoliths and also, according to HEINCKE's investigations (10), by means of the bones, has been extremely helpful to these investigations; and no less also *the method of marking plaice* for the determination of their migrations, which was introduced by PETERSEN and adopted practically everywhere and has been carried out on a large scale by almost all the participating countries. The first preliminary reports on the results of these investigations of Committee B in the years 1902 to 1904 were published in the General Report of the International Council of 1905. These reports at once spread new light on the general distribution of the different stages of the plaice in the whole North Sea and thus laid down once and for all the main lines of the distribution. It appeared at the same time, however, that these first results of the international cooperation, both in content and methods, were still far from being able to permit us to grapple with and solve satisfactorily the difficult problem of overfishing. To attain this end it was absolutely necessary, that the analysis of the scientific hauls of the research-steamers, which for the rest required to be considerably augmented in number, should be supplemented by the most extensive analysis possible of the, numerically and quantitatively, enormous catches of the practical plaice-fishery, which were landed at the fishing-ports.

In order that this branch of the work, which had been barely started previously, might be advanced more rapidly, the following resolution was passed by the Meeting of the International Council at Hamburg in February 1904 (12):

"The International Council considers it highly desirable, that full and careful statistics be collected at the chief ports of entry on the question of the destruction of small fish, with especial reference to the size, place and season of capture of young plaice and other flat-fish, and desires to bring before the Goverments concerned the necessity of allocating out of the funds for fishery research at their disposal, a provision sufficient for the thorough carrying out of this portion of the work.".

At the next Meeting of the International Council in Copenhagen, July 1905, it was

resolved, as a further consequence of the above resolution and as a means to obtain exact, statistical knowledge regarding the quantity and composition of the landings of fish in the whole region of the International Investigations, that an annual Bulletin should be drawn up by the International Bureau at Copenhagen, which would bring together the following statistical data from all the participating States:

1. Total quantity and value of each single species of fish landed in each country for the whole region.

2. The same data, divided according to the principal regions of the international field of enquiry, for example, North Sea and Skager Rak, Kattegat, Iceland and the Færoes etc.

3. For the principal food-fishes, plaice, haddock, cod, herring etc., the same data for each month.

4. The average annual price obtained on the market for each species of fish.

5. Number, kind and size of vessels taking part in the fisheries in each country.

With regard especially to the *plaice*, the following statistical data had to be collected at the fishing ports:

1. The monthly, total quantities of plaice landed, if possible from direct weighing, measurement and counting or in part by estimation.

2. Composition of the total quantities with regard to the different trade-categories (e. g. large, medium, small).

3. Measurements as frequently as possible of the quantities landed of the smallest class (in centimetres).

4. The most accurate determination possible of the actual place of fishing, from which the plaice samples measured came.

As a result of these resolutions of the International Council in 1904 and 1905, very intensive, statistical investigations were begun in most of the participating countries with regard to the plaice fishery, all according to a more uniform method. It proved already at the beginning and even more so during the progress of this work, that, for the solution of the plaice question, especially of the question of practical protective measures in the form, for example, of restrictive size-limits — *the analysis of the quantities of plaice landed, by number, length and weight,* belonged to the most important and indispensable information to be derived from fishery statistics. It proved to be necessary not only to determine the number, size and weight of the smallest trade-category, but to analyse all the trade-categories, in fact all the landings of plaice on the market in the same manner as the scientific hauls of the research-steamers. Such measurements from cm. to cm. are absolutely necessary, to obtain a reliable picture of the true composition of the quantities of plaice landed from the North Sea and to make them comparable with the original hauls made at sea; they are necessary, above all, to enable us to judge of the importance and value of a size-limit, which indeed must be determined to a centimetre, and thus also to estimate the number, weight and value of the plaice to be protected in proportion to the total quantity of the landings and the probable, total stock of plaice in the sea. These measurements from cm. to cm. offer the only possible means also, of translating into *numbers* with sufficient accuracy the quantities by weight of plaice landed, both for the whole quantity and for the different market-classes; and

this means a valuable extension of our knowledge regarding the plaice fishery and the stock of plaice in the sea.

When the indispensability and importance of these *market-measurements* for the solution of the plaice question had been recognized and the different countries had begun to devote more time and money to this part of the international work, the fruitfulness of the method became so clear, that even the question of possible protective measures could be taken up for serious discussion. Evidence of this was forthcoming especially in *two reports*, which were laid before the International Council at its Meeting in London in June 1907. Firstly, the "*Summary Report on the present State of our Knowledge in regard to the Plaice and Plaice Fisheries*" (14), which was drawn up by a special Committee consisting of PETERSEN, GARSTANG and KYLE, and secondly, a German report by HEINCKE and HENKING "Über Schollen und Schollenfischerei in der südöstlichen Nordsee" (15). The first endeavour was made in these two reports, on the basis of the results available from the International Investigations, to propose the introduction of a definite, legal size-limit for the plaice of the North Sea and Kattegat; at the same time, the possibility of its practicability was discussed as well as the possible, initial disadvantage and later usefulness for the fishery.

In the following resolution the London Meeting of 1907 proceeded further along these promising lines, which seemed to lead directly to practical results in the interest of the fisheries (16):

"That in drawing up the Report on their work during the years 1902—07 the Council shall have special regard to reaching a conclusion as to the desirability or otherwise, of preventing the capture of undersized plaice.

"That with this object each country interested in the North Sea plaice fisheries should furnish answers as far as possible to the following questions:

"Whether small plaice taken by the trawl can and, having regard to the ordinary practice prevailing in trawlers, would be returned to the sea alive;

"Whether any, and if so what, size limit would make it unremunerative to fish on grounds on which such fish occur in greatest abundance;

"Whether if excluded from such grounds by reason of the imposition of a size limit, it would be remunerative to fish elsewhere notwithstanding the imposition of the size limit."

At the next Meeting of the International Council, in July 1908 at Copenhagen, there was a partial reorganisation of the biological programme with the aim of making the results of the International Investigations as soon as possible useful to the practical fisheries, all in accordance with the wishes of the participating States. With regard to the *plaice*, the most important food-fish of the North Sea for the time being in practical regards, the following resolution (17) was agreed to:

"With regard to the plaice, the Council believe that a very large amount of information has already been gained, but the data are at present insufficiently collated and summarized. The Council, therefore, recommends, with a view to throwing light on the points referred to in the resolution passed in London in 1907 (Proces-Verbaux, VII, 1907, p. 42) that, in the first instance, a report should be furnished by each country on the whole of the work that has been done therein on this subject, and that the official delegates in each country shall to the utmost of their power be responsible for these

reports being rendered to the Council not later than the 1st February 1909; and, in the second instance, that a general Editor be appointed, who shall receive a remuneration for his incidental expenses and whose duties shall be to collate and summarize the above reports in a draft general report, whiah he shall furnish by a date to be fixed by the Bureau, and which after being circulated among and revised by the original collaborators, shall be discussed by the Council and shall form the basis of their corporate reply to the several Governments in regard to the plaice fishing."

This resolution of the London Meeting is concerned with the three questions referred to above, which deal with the vitality of fish caught in the trawl and the possibility of an effective size-limit. These questions are brief, yet full of meaning and requiring for their solution, which is desired by every one of the countries interested, the entire sum — weighed deliberately — of all the information, which the International Investigations have so far collected with regard to the plaice, not only the biological and that from the fishery statistics, but above all the full results of all those investigations which have been made on the distribution of the plaice of the North Sea according to size and age, and on the composition of the scientific hauls and the landings in the fishing ports.

In most countries, the material desired was already so enormously great by the year 1908, that the task of preparing special summaries in the form of separate reports could not be completed by any single country before the time-limit proposed, 1st of February 1909, and indeed this is not to be wondered at. The main reason, which led to a further postponement of the preparation of these separate reports, was the fact, that the principal investigations and the true kernel of these reports, namely the *accurate statistical information* to be obtained on the markets on a large scale, above all the *market-measurements,* had not been carried out to a sufficient extent in most countries by the year 1908; in fact, they had in part only just been started.

Thus, it has happened, that the preparation and publication of the separate reports of the participating States on the plaice question was spread over more than two years, until August 1911. The following reports, arranged according to the date of their delivery, have been received in printed form by the International Council and the General Editor on the plaice question.

HOLLAND. Bericht über die holländische Schollenfischerei und über die Naturgeschichte der Scholle der südlichen Nordsee. Von Dr. H. C. REDEKE. Received July 1909.

DENMARK. Bericht über die dänischen Untersuchungen über die Schollenfischerei und den Scollenbestand in der östlichen Nordsee, dem Skagerak und dem nördlichen Kattegat. Von A. C. JOHANSEN. Received May 1910.

ENGLAND. Report on the Research Work of the Board of Agriculture and Fisheries in relation to the plaice fisheries of the North Sea. Vols. I—III. Special Statistics. Size and Weight. 1908—1910. By WALTER S. MASTERMAN. Completed and received September 1910. — Vol. IV. Biological Statistics. Age and Sex. By A. T. MASTERMAN. Received in part (for the year 1905/06) July 1911.

BELGIUM. Contributions a l'Etude biologique et économique de la Plie. By G. GILSON. Received September 1910.

GERMANY. I. Über Schollen und Schollenfischerei in der südöstlichen Nordsee. Von FR. HEINCKE und H. HENKING. Received June 1907.

II. Die Statistik der deutschen Schollenfischerei im Nordseegebiet. Von H. HENKING. Received August 1911.

Scotland, Sweden and Norway have not sent in any report on their plaice investigations, in the sense of the Copenhagen resolution of July 1908.

According to the resolution of July 1908 the duty devolved upon the General Editor of the plaice question, of summarizing and coordinating into one general Draft-Report the reports received by the Council from the separate countries; this Draft-Report, after revision by the authors of the special reports, should then be submitted to the International Council in its final form and should form the basis for their corporate report to the different Governments.

This task of the General Editor is by no means an easy one. If, in accordance with the resolution, he should do nothing more than quite objectively bring together and coordinate the material contained in the special reports, the last purpose of the General Report, namely, to give a reliable picture of our present knowledge of the plaice and the plaice fishery, would not be achieved. For the material contained in the special reports yet published, though certainly very enormous and valuable, is still imperfect and not arranged by all authors in the same way according to a uniform method. For example, in none of the reports is there a special and thorough discussion or answer to the first question of the London resolution of 1907: "Whether small plaice taken by the trawl can be returned to the sea alive?" There is a great lack of uniformity in the special reports in reference to the principal investigations on the plaice question, namely, in the analysis of the scientific hauls of the research-steamers and of the landings of plaice at the fishing ports. The analyses of the scientific hauls were not dealt with in the report from any country, except in the first, older part of the German Report. The analyses of the plaice landings, that is, the market-measurements, only receive the treatment their importance merits in the English and second part of the German Report; in both of these countries they have been carried out on a very wide scale and according to reliable methods. In the reports of most of the other countries, however, they are kept relatively too much in the background. Again, the report of the one country, e. g. England, in its analysis of the catches lays just as much value on the weight as on the length of the fish, whilst that of another, e. g. Germany, is contented almost entirely with the length measurements. Here, lastly, the biology of the plaice, so far as it stands in inseparable connection with the solution of the plaice question, with regard for example to age, growth, migrations etc., is correspondingly dealt with in detail, there it is but little or not at all discussed.

This incompleteness of the special reports and the lack of uniformity in the treatment of the material in them made it necessary for the Editor of the General Report, in many cases, to refer back from the special reports to the original sources and to papers lying quite outside these. It was not a matter of merely ranging the material of the special reports in serial order, he has been obliged to rearrange it in part according to uniform principles. Thus, from a simple collective report it was necessary to prepare a uniformly elaborated General Report, which endeavours to give as accurate a picture as possible of our present knowledge and to discuss at the same time the views and wishes, which prevail in the different countries regarding the usefulness and practicability of certain protective measures.

The following General Report has arisen under the stress of such necessities and from the principles discussed. It deals only with the practical side of the plaice question. Since, however, the practical problems to be solved are rooted deep down, essentially in the biology of the plaice, a theoretical and purely scientific report on the biology of the plaice should as a matter of fact precede this practical report on the plaice fishery. The preparation of such a biological report has been desired almost everywhere and is also included in the design of the present author. But the practical plaice question is at present by far the more important and calls for an early solution, and it seems expedient to postpone this biological report and append it later to the practical report as the second part of the General Report on the plaice and plaice fishery. Naturally, however, it will be necessary to bring in quite a number of the principal results of our biological investigations on the plaice into the statement and discussion of the practical questions in this report.

For the sake of a comprehensive view, the enormous amount of material forming the basis of this report must be dealt with systematically in subdivisions, which, naturally, frequently differ from those used in the special reports. Arranged in order these subdivisions will be:

I. 1. *The general distribution* of the plaice in the North Sea and in the different parts of the North Sea.
   2. *The subdivision of the North Sea* into different areas, having regard to the distribution of the plaice and the practice of the plaice fishery.
   3. *Means and methods for determining the composition of the catches and stock of plaice. The scientific hauls and market samples* as a means of displaying the distribution of the plaice in the North Sea and of determining the composition of the plaice stock and plaice landings.

II. *The amount and composition of the plaice landings and plaice stock in the North Sea and neighbouring waters.*
   1. The amount and composition, by number, length and weight, of the quantities of plaice landed by the fishery in the different countries, in the different months and from the different areas of the North Sea. The relative amount of immature plaice in the landings.
   2. The amount and composition of the actual hauls made by the fishermen but not wholly landed. The composition of the hauls with regard to sex.
   3. The composition of the actual stock of plaice in the North Sea and its probable, absolute amount. How great are we to estimate the percentage of the plaice stock, by number and weight, which is taken yearly from the North Sea by the fishery?

III. *Are there any signs of an actual overfishing or of an essentially increased tax on the plaice stock of the North Sea through the increased fishing?*
   1. The decrease of the large and increase of the small plaice in the catches as probable signs of a permanent change in the composition of the stock of fish produced by the fishery?

2. The new and still little fished grounds outside the North Sea. Iceland, the Færoes, Barents Sea. The difference in the composition of the North Sea catches from the catches made on these new fishing grounds as a consequence of the greater fishing.
3. Has a diminution occurred in the density of the plaice stock of the North Sea as a result of the fishery?
4. Is the productivity of the North Sea great enough to make good the annual removal of 20, 30 or more per cent of the stock?

IV. *The introduction of protective measures for the plaice.*
1. The necessity of introducing *international* protective measures.
2. Protective measures in the way of closing times, closed areas or the prohibition of certain apparatus.
3. Protective measures through size-limits or prohibition of landing without direct restriction of the fishery.
4. Can the fish below a certain size which are caught by the different nets be returned to the sea alive and capable of living?

V. *Size-limits and the restrictions imposed by them on the fishery.*
1. How high must a size-limit be, in order to guarantee a real and effective protection of the undersized fish?
2. The influence of different size-limits on the yield of the fishery in the different countries.

VI. *The probable influence which an effective protection of undersized plaice and a more rational and more productive fishing would exercise on the maintenance of the plaice stock.*

VII. *The desirable height of the size-limit for the plaice in the whole North Sea to be determined by international agreement.*

VIII. *Summary of the results.*

I.

DISTRIBUTION OF THE PLAICE AND METHODS OF INVESTIGATION.

THE accurate determination of the distribution of the plaice and of the areas frequented by its various age-groups forms the basis of all investigations on the biology of the plaice and on the practical questions of the plaice fishery. A general discussion of this distribution of the plaice and especially of the scientific means and methods that are employed for its investigation, must therefore precede all other considerations.

1. The general distribution of the Plaice in the North Sea, Skager Rak and Northern Kattegat.

The main features of the distribution of the different age-groups of plaice in the North Sea and immediately adjacent waters were already determined by the investigations of the research-steamers soon after the beginning of the International Investigations. The very youngest stages of our fish, *the pelagic eggs of the plaice* (18), are found in the months of December to April, in greatest quantity in February, over wide areas of the North Sea. They are distributed over the deeper parts from about 25 to 30 m., yet by no means equally over the whole region; in certain parts they are unmistakably in very much greater, relative numbers or density than at others, and we may thus with some right speak of different and separate, more or less sharply defined *spawning-regions*. The spawning region in which plaice eggs have been found in by far the greatest density, over 100 to 600 eggs per square metre of surface, is the smallest in area and lies in the south-west angle of the North Sea between 51° and 53° N. L. near the entrance to the Channel; there is a second spawning-region, much greater in extent but with a much smaller density of eggs (up to 30 per square metre) in the south-eastern part of the North Sea between 54° and 55° N. L. outside the 40 m. line; a third at the same geographical level in the western North Sea in the area of the Flamborough Head grounds; a fourth on the Great Fisher Bank; a fifth off the Scottish coast, especially in and off the Moray Firth; a sixth, lastly, in the northern Kattegat. These last four also seem never to have a greater density of eggs than

30 to 50 per square metre. Between these spawning-regions lie, as poor, almost eggless regions, the Skager Rak, the region north of the Great Fisher Bank as far as the Scottish coast and above all the Dogger Bank.

Whilst the eggs of the plaice are always found only in the open sea over depths of 40 and more metres, the youngest bottom-stages (19), which, on completion of their metamorphosis from an asymmetrical larva to a fully-formed small plaice, measure about 14 to 20 mm., occur practically without exception only in the immediate neighbourhood of the coast in quite shallow water from 0 to 3 metres, in the North Sea and adjacent parts of the Skager Rak and Kattegat. The larvae of the plaice and the transitional stages to the adult form must therefore all migrate from the spawning-grounds in open sea into the coast, whether passively under the influence of the currents or actively through their own movements, is not yet known. For the plaice of the North Sea this exclusive occurrence of the youngest bottom-stages in the immediate neighbourhood of the land is *extremely characteristic*. The plaice of the Belts and of the true Baltic, according to recent investigations (20), behave quite differently; their first bottom-stages are not found immediately on the coast but in deeper water. Quite different also is a nearly related species, the *dab (Pleuronectes limanda)*, whose first bottom-stages occur at the same places as the pelagic eggs and are thus scattered over the whole North Sea and in the most different depths, but almost never in quite shallow water close to the shore (21). So far as the investigations go, the young plaice fry occur almost everywhere on all coasts within the whole region in question here, on the shores of the islands, in the mouths of all rivers and bays and for the most part on sandy or sand-and-mud grounds. The only restriction on their occurrence seems to be, that the young plaice in contrast to the young *flounder (Pl. flesus)*, which penetrates into almost freshwater, requires a certain minimum of salinity of about 20 to 14 ‰.

As the whole plaice population of the North Sea thus takes its origin from the shallow, coastal region, the quite young plaice of the first year must occur there in very large quantities. As a matter of fact, their density at certain places is quite enormous, especially in the months of April to October, when they gradually grow to a length of 6 to 10 cm., moving out, as they grow, farther from the beach into somewhat deeper water. During the winter-months, from about November to March, the growth of the young plaice is arrested and it is very probable that they hibernate — in somewhat deeper water, 5—10 m. — buried in the sand (22).

With the second year of life there begins a very gradual and, from year to year, increasing dispersion of the young plaice from the coast outwards to the open sea and in general also into ever greater depths. As the absolute number of plaice of the first year must become reduced with every succeeding year, each year-group containing fewer individuals the older it is, and as the dispersion of the young plaice proceeds from a relatively narrow coastal zone out over a wide and extensive region, we have the following general rule for the distribution of the plaice according to age:

"*The size and age of the plaice of any definite part of the North Sea are inversely proportional to the density of their occurrence, but on the other hand directly proportional to the distance of the locality from the coast and its depth.*" The smaller and younger the plaice are, consequently, the nearer they occur to the coast and the

shallower the water, whilst the larger and older the plaice are, the farther out to sea they are met with and as a rule in greater depths (23).

However certain this general rule may be — we might well call it the *law of distribution of the Plaice* — it applies, nevertheless, like all similar rules, only to the average of the single cases. Thus, it is not natural to expect, that strictly taken the shallow coastal zone only contains the first year-group of the plaice, the deeper zone a little farther off only the second year-group and so on. It is much more the rule, that in every part of the North Sea where plaice are caught, there are always plaice of different lengths and different year-groups mixed together (24). But always in such a way, that *one or at most two successive year-groups* compose the great majority of the plaice and determine *the average size and average age*, which correspond with the general rule for the distribution. In the best investigated part of the North Sea, for example, the south-eastern part, we find plaice of different size and different age, from about 10 to 35 cm. in length and in their second to sixth year, living together and often in the same haul, in the zone from about 10 to 25 m. deep. Nevertheless, 60 to 90 % of these plaice are about 12 to 20 cm. long, thus in the second or third year, and without exception immature, that is, still unripe fish. Along with these but much fewer in numbers we find the fourth, fifth and sixth year-groups in varying amount, decreasing according to size and age. On the Dogger Bank, again, plaice are caught from 16 to over 70 cm. in length, but about 75 % of the total quantity are longer than 30 cm. and older than 4 years; the average length may be taken at about 40 cm., the average age at 6 years. In a third area, between the coastal grounds of the south-eastern North Sea beyond the 40 m. line and the Dogger Bank, thus nearer the coast than the latter and embracing the fishing grounds between 40 to 60 m., the so-called Mud Banks, the Oyster Ground and Clay Deep, we likewise find plaice of 16 to more than 70 cm. in length, but of these less than half only are over 30 cm. long and their average length amounts to about 30 cm. with an average age of approximately 4 years. On the most extensive, most distant and deepest plaice grounds of the central part of the North Sea, e. g. the Great Fisher Bank, Fladen Ground etc., the plaice are from about 30 to over 70 cm. and their average length may be taken at about 45 cm., their average age from 7 to 8 years (25).

The *density* of the plaice in the various parts of the North Sea follows quite similar lines. As approximate measure of the density we may take the number of plaice which are caught by the ordinary trawl in one hour under the ordinary speed. On the basis of the hauls of the research-steamers, for example, we find, that the density on any shallow zone of the south-eastern North Sea of 10—25 m. in depth, with a plaice population mostly in the second and third years, amounts to about 300 plaice per trawling-hour on an average, but with local fluctuations from 30 up to several thousands (26). In the area embracing the Mud Banks, Oyster Ground and Clay Deep and containing plaice with an average age of 4—5 years, their density may be estimated at about 15 per trawling-hour with variations from 1 to 150. On the Dogger Bank with plaice of 6—7 years on an average, there is only an average density of about 5 to 7 per hour, varying from 1 to 12; and in the areas north of this, containing the largest and oldest plaice, the density is only about 2 per trawling-hour. For obvious and comprehensible reasons the density decreases at a higher rate than the length and

age increase. It is a peculiar characteristic of the law of distribution of the plaice, that in the southern and south-eastern part of the North Sea, the greater distance from the coast seems of more importance than the greater depth for the increase in size and especially the decrease in density (27). This is most clearly seen in the case of the Dogger Bank, which is only 20 to 40 m. deep but lies centrally in the North Sea and far from all the coastat regions of the young fry; in spite of its shallow depths it shelters very large and old plaice. In marked contrast to this, we have the above-mentioned, small spawning-ground of the plaice in the south-western North Sea off the Channel (C_3), which has a depth of 40 to 60 m. but lies very much nearer to the coast than the Dogger Bank; here also we find plaice of all sizes from 16 up to more than 70 cm. in length, but only about 25 % of these, against 75 % on the Dogger Bank, are over 30 cm. long and the average length must be taken at about 28 cm. with an age of 4 to 5 years. The distribution is somewhat different again in the north-western part, from 55° N. L. northwards. Here as everywhere on the whole western side of the North Sea the bottom slopes more rapidly and more steeply towards the deep water than on the east side; the *isobaths*, i. e. the lines of equal depths, lie much closer together. The 80 and 100 m. lines, which practically limit the plaice region proper of the North Sea, are only 10 to 100 miles from the coast. In this region, for example in the Moray Firth on the Scottish coast, the whole life of the plaice, from the youngest bottom-stages on the shore up to the spawning, largest and oldest fish, is passed within a very restricted and very much smaller area than in the southern and especially eastern part of the North Sea. In agreement with this the density of the plaice decreases very rapidly at short distances from the coast. Similar conditions with regard to the depth and decrease in the quantities of plaice are also found in the region of the Skager Rak. This narrow extension of the plaice region in the northern North Sea is only compensated in small part by a greater density of plaice. We may consider it certain, that the northern North Sea has in general a smaller plaice population in numbers at all ages, so that the absolute quantity of the youngest bottom-stages living in the coastal region is also very much smaller than in the southern and south-eastern North Sea. If we draw a line from about Flamborough Head on the English coast towards the Skaw, the part lying south of this, including the Dogger Bank, is *the true plaice region* (28), certainly embracing far over 90 % of the whole plaice population of the North Sea. Here, in the extensive, shallow, coastal zone down to 25 m., on the so-called *young-fish grounds*, we have the young plaice of 1 to 3 years old, which by their enormous numbers constitute the increment for the plaice fishery of the North Sea. The various points in the North Sea, where approximately the same average size of plaice has been found by the research-steamers, may be joined together by lines and we thus obtain *lines* or *zones of equal, average length.* The accompanying Chart, drawn up in this way after GARSTANG (29), gives a picture of these lines of equal, average length for the plaice. It may perhaps be improved in details, but it is sufficiently accurate on the whole. In the intermediate zones between two lines of equal, average length, are given the data regarding the predominant age-groups in Roman numbers, as also some information regarding the density of the plaice per trawling-hour.

The distribution of the plaice in the North Sea indicated here in broad lines is the

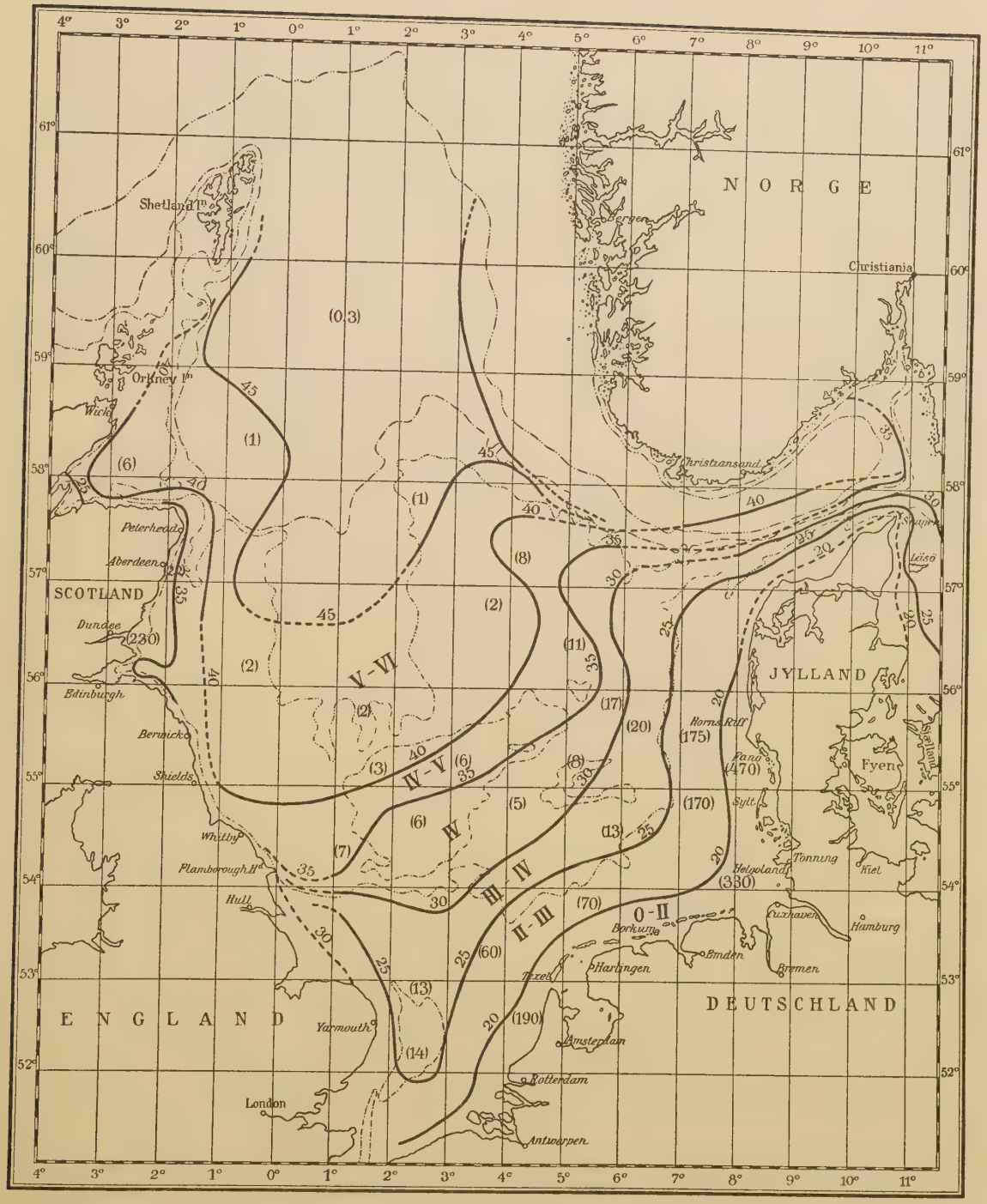


Fig. 1. *Distribution of the Plaice in the North Sea according to Size* (after GARSTANG, Distribution of the Plaice pp. 65—133, 1909).

The lines of the Chart are lines of equal average length for the plaice (marked in cm. on the lines). In the zone between two lines the sizes which lie between the cms. indicated on the lines are predominant. The Roman numbers indicate the predominant age-group of plaice within the zones in question. The Arabic numbers in brackets give determinations of the density of plaice at various points, i. e. the number caught per trawling-hour of the research-steamers.

outcome of a gradual *migration* of the growing plaice from the coast out to the open sea (30). This seaward migration of the plaice is not continuous in time, at least not in the first years of life, but proceeds intermittently and more or less regularly at definite seasons of the year, in the summer months from June to September. It begins properly speaking already in the first year of life, when the young fry not yet one full year old, the so-called O-group, move out in late summer and beginning of autumn from the quite shallow, 5 metre zone into somewhat deeper water (down to 10 m.) and there pass the winter buried in the ground. On recovering from the winter-rest, in March, the plaice of the so-called I-group, which are now in their second year and measure about 7 cm. on an average, migrate further out, mainly in late summer, and on growing up reach out to about the 20 m. limit. After another winter-pause they travel over a further step on their way, out over the 20 m. line, in the following summer as 3rd year group or the so-called II-group; and so on in the following years. This general course of the migration seawards of the plaice, which has been proved directly by the liberation and recapture of marked plaice (31), becomes modified in details in various directions and it is just these modifications, which give rise to the typical and observed kind of distribution of the age-groups in the different regions.

1. *The seaward migration of the plaice* is not accomplished in such a way, that the total stock of one year-group moves onwards from year to year as a whole, pushing the whole of the previous year-group before it; this step-by-step movement applies rather to the principal mass only, not to all individuals of the same age. In this way we have a mixing of the different year-groups within each of the successive zones out from the coast with, however, the great majority of the stock consisting of one or a few year-groups. As this mixing of the successive year-groups on the year-long migration from the coast towards the distant and deep plaice grounds is a constant process, it follows necessarily, that the number of the year-groups present in one local stock is so much the greater, the further the locality is from the coast. In the shallow, coastal zone of the south-eastern North Sea out to a depth of 20 m. we find almost exclusively, with very few exceptions to be mentioned later, the plaice of the first to sixth year-group, on the Dogger Bank and the grounds still further north plaice of the fourth to the twentieth and still higher years; thus, only 6 year-groups on the former, but more than 20 on the latter.

There is a second point of importance here. As a result of the great difference in the individual rate of growth of the plaice, as of all fishes, the individuals of the same age naturally have not the same size everywhere; this varies indeed very considerably about an average value and the more so, the older the fishes are (32). Observations have shown, that the larger individuals of one and the same year-group, e. g. of the fourth (so-called III-group), are in general met with farther out to sea than the smaller, in other words, that the average length of this year-group is greater in the outer areas than in the inner (33). This may be due to two causes. Either the larger individuals of a year-group go in the van of the migration or the growth of the plaice experiences a relative acceleration, as soon as they come farther out to sea. Probably both causes are at work. What is certain is, that the plaice really increase on an average relatively more in length and especially in weight, when they reach farther out to sea and that is only possible, if they find richer nourishment on the outer grounds

than nearer the land, either because this food — consisting in the main of the bivalves and worms living on the bottom — is absolutely richer or because the lesser density of the plaice on the outer grounds means for each single plaice a greater amount of food than in the more densely populated coastal regions. As evidence in this direction we have the experiments with marked plaice; these have shown, that plaice liberated at the coast and recaptured after some time farther out to sea have grown on an average more strongly than the plaice liberated at the same time and place but recaptured in the coastal regions (34). Very convincing in this respect are the experiments with the *transplantation* of plaice (35) from the shallow coastal waters of the North Sea over to the Dogger Bank, which have been made both from the English and the German side. According to these experiments the plaice of about 18 to 40 cm. in length, which were transplanted to the Dogger, have grown on an average *three to four times as much* in length and weight, during one single, yearly period of growth, as those which were liberated at the same time on the coastal grounds and recaught there. The Dogger Bank, which is not at all a spawning-ground of the plaice, as remarked above, must therefore be all the more *a feeding ground*, containing probably more nourishment for the plaice, especially in the form of bivalves, than any other area of the North Sea (36). On the southern Mud Bank lying east of the Dogger the plaice show a much smaller growth when transplanted than the above.

2. From a whole series of observations, both from the distribution of the plaice at the different seasons of the year and from the marking experiments, we must conclude, not only that *the seaward migration of the younger year-groups of the plaice comes to a standstill in the winter-months, certainly from November to March*, but that the growth, which is greatest during the summer and migrating months, also ceases for a time whilst the young plaice, so far as they have not yet reached the spawning stage, make the *winter period a time of rest*, sinking down into the ground and taking no nourishment (37). The principal ground for this conclusion is, that the hauls in winter generally show quite an *extraordinary decrease in the density of the plaice* population, by contrast to the hauls of the rest of the year, in those regions of the North Sea where the first 3 to 4 year-groups of the plaice are predominant. In the region between Heligoland and the mainland with depths of 20 to 40 m., for example, the density may fall from 300 and more per trawling hour down to 20 and less on one and the same fishing ground. At the same time the average size of the plaice rises very greatly in a characteristic manner and often so considerably, that a haul in the zone of 20 to 40 m. shows the same average size of plaice and the same composition as a summer haul in the deeper region from 40 to 60 m. farther out to sea (38). In March the young plaice which have disappeared in winter appear again in enormous quantities in the hauls, often quite suddenly and unexpectedly, and after a short time, in the course of April and May, the previous summer density is again attained. As the small plaice are not taken either on the more distant and deeper grounds in the winter, the only permissible explanation of this phenomenon is, that *the small plaice remain on their old grounds in the winter, but bury themselves so deeply in the ground, that the ground-rope of the trawl passes over them without stirring them up and catching them.*

3. The plaice which have already reached the age of maturity, ripen their sexual products in the beginning of winter. Although the growth in length of the body also

pauses in these during the winter, whilst the sexual products increase in weight, yet the spawning plaice naturally take no winter rest, but remain in movement and active in the exercise of their reproductive function. The males, which are in general considerably smaller than the females, are sometimes mature already at the end of their second year, the majority however at the end of the third year at an average length of about 20 cm. and all those of 25 cm. in length are in this condition, at least in the southern part of the North Sea; the females, which are larger, only become mature 1 to 2 years later than the males and then have an average length of about 35 cm. (39). At the beginning of winter, both sexes on reaching the mature size show a more or less distinct movement in the direction towards those parts of the North Sea, in which they mainly spawn and which have been briefly outlined above. Both the Dutch and the English marking experiments have definitely shown such a *spawning migration* with regard to the important spawning-ground in the south-western angle of the North Sea (40). Since the large and old plaice naturally take part also in the spawning, the spawning migration is very often directed landwards instead of seawards. This *landward, spawning migration* of the larger and older plaice is very probably the cause and reason, why large plaice of 50 to 70 cm. in length are caught on the shallow, coastal grounds of the southern and south-eastern North Sea in the winter months, in towards the 20 m. line and even closer to land, though in the summer months they are never met with or only quite exceptionally and always in considerably smaller quantities than in winter (41).

4. In addition to the regular seawards and annually intermittent migration of the growing plaice and in addition to the more irregular migration of the mature plaice towards the spawning grounds, there seems to be still a third, regular but always landward migration in the shallower regions of the southern and eastern North Sea out to about 50 m. This occurs in the early *spring months* immediately after the termination of the winter rest in March and April, and is taken part in mainly by plaice of 25 to 40 cm. in length, accompanied probably by still larger and large plaice which have finished spawning. This migration is shown apparently by the results of the plaice marking experiments, so far as these are trustworthy, and is probably one of the principal reasons, why in the months of March and April dense shoals of marketable plaice occur in the Danish and German, coastal areas of the south-eastern North Sea in the neighbourhood of the 20 m. line — denser, in fact, than later on in the summer. If this landward migration in spring really exists (42), it can only be regarded as a migration in search of food, leading the plaice, those which have started out from their winter rest and those exhausted by spawning, all without exception thin and out of condition, as a matter of habit towards those feeding grounds, which at this time are specially rich in plaice food and these are probably the shallower grounds lying nearer to the land.

The plaice population of the North Sea is thus *by no means stable;* it is in constant and regular movement, partly towards the land, partly seawards. *This inner movement* begins in the months of March to May with a migration of the pelagic plaice larvae, radiating out from the spawning regions of the open sea and directed towards the coasts. This changes over into a seaward migration along the bottom of the sea in summer, as soon as the young plaice living in the coastal region of the North Sea begin to grow up, and ends again on the spawning regions in winter, when these plaice

in the course of some years become sexually mature. Whilst the mature plaice in these areas proceed to spawn — from December to April — and the larger of them, which live in summer already farther out to sea, mostly move landwards towards the spawning grounds in the beginning of winter, there is a pause at this time in the movements of the young, still immature plaice, which hibernate on the shallower coastal grounds. The older, spent plaice and the younger, just starting out from their winter rest, tend to move in landwards in March and April towards specially rich feeding grounds, before they again turn seawards in the course of the summer.

In order to illustrate more fully this inner movement of the plaice population, which is obviously connected with the feeding and reproduction of our fish and with the change in the seasons, we may divide the year into two sections, calling these *summer* and *winter*. The *plaice summer* embraces the months of May to October; it is the period of growth of the plaice in the North Sea, when it feeds and grows, and also the period when the plaice shoals, in wandering from one feeding ground to the other, gradually move further and further out to sea. The *plaice winter* embraces the months of November to April. This is the resting period for the younger, immature plaice; for the older, mature plaice it is the spawning period and for all the period of no increase in length. The common migration seawards of the plaice ceases and changes over into one in a reverse direction, thus landwards, for the plaice of intermediate and larger sizes; at this period we have the enormous migration of the pelagic plaice larvae from the spawning grounds landwards to the coast.

Apart from this regular and annual, inner movement of the plaice population, which is always on a large scale, no lateral displacements of large quantities of plaice from the eastern towards the western side of the North Sea or the reverse have as yet been discovered with certainty. The experiments with marked plaice have shown, it is true, that a few, specially large individuals of the first and second year have been recaptured very far, to over 250 miles, from the place of liberation (43); but these extreme cases do not amount to more than 1 % of the plaice recaptured. Not a single one of the recaptured, marked plaice has wandered from the English coast over to the German or Danish coast; in the reverse direction, some few out of thousands have migrated in the south of the North Sea from the Heligoland area as far as the mouths of the Rhine. Very small also is the percentage of marked plaice, which have migrated from the Skager Rak into the Kattegat or from the Kattegat into other waters (44). By far the great majority of all marked plaice recaptured, fully 90 %, have been taken not more than 50 miles in a straight line from the point of liberation and about 96 % have not exceeded a distance of 100 miles. So far as we can conclude anything with certainty from the marking experiments, this means that more than nine-tenths of all the plaice of the North Sea do not migrate out from the coast more than 100 miles, that is, practically not more than the distance to the nearest spawning-ground from the starting-point of the migration. In the present state of our knowledge, therefore, there is no sufficient reason for doubting, that the young and growing plaice in the different, coastal regions of the North Sea, as maturity approaches during their general migration seawards, gravitate towards the spawning-grounds which lie nearest them. It is slightly different with the question, whether the pelagic larvae of the plaice, which move from the spawning grounds towards the coast, are distributed over considerably greater distances than

the older bottom-stages, by means of currents flowing in certain directions. We might ask here, for example, whether and to what extent the pelagic plaice fry, born on the rich spawning-ground of the south-western North Sea, may be carried by the current running in an easterly direction from the English Channel along the south coasts of the North Sea, into the south-eastern angle of the North Sea, the German Bight in the narrower sense, and there contribute to the increase of the stock of young plaice of the first year in this area. It is clearly possible that this may occur, but the proofs for or against are not yet to hand.

The conclusion drawn from the marking experiments, that regular displacements of large quantities of plaice do not occur over a local spawning ground or over several spawning grounds from one part of the North Sea to another, is supported by the fact, that *several local races of the plaice*, distinguished by morphological characteristics, very probably exist beside each other in the North Sea, in such a way, that each of the races occupies a more or less sharply defined area of the North Sea (45). The new methods of race-investigations, which enable a sharp definition and distinction of the local forms of a species to be made, have also been applied to the plaice and show unmistakably, that the *plaice population of the northern seas of Europe is not a morphological unit* but falls naturally into a number of local races or subspecies, in part very sharply defined from one another. Such well-marked forms of the species *Pleuronectes ptatessa* are, for example, the plaice of the northern Polar Sea (Barents Sea), the plaice of the Belts, the plaice of the true Baltic, the plaice of the North Sea and the plaice of Iceland. The distinctive characteristics of these subspecies consist often of very considerable differences, partly in the average number of vertebrae and fin-rays, the relative size of different dimensions of the body and in the form and structure of the skeletal parts, partly in the constitutional size of the body and rate of growth. For example, the plaice of the true Baltic is constitutionally a very small race, which even at a great age very rarely reaches a length of 50 cm., and at the same time a very slow race in growth; its average numbers for vertebrae and fin-rays are lower than in any other race, for the vertebrae about 42.5, dorsal fin about 67 and anal fin about 50. On the other hand, the plaice of the Polar Sea (Barents Sea) is constitutionally a large plaice, but nevertheless a slow-growing race, with the highest number of vertebrae and fin-rays, namely, 43.5, 74.2 and 54.7 respectively. By comparison with these two subspecies of the Baltic and Polar Sea, the plaice of the North Sea and Iceland are constitutionally medium-sized to large and at the same time quick-growing races, which take up an intermediate position in morphological characteristics. The second, biological part of this Report will deal in detail with this question of the races of plaice and their distinctive characteristics. We must note here, however, that there is a great probability for the existence of *at least two different races of plaice within the boundaries of the North Sea.* These, which may be called provisionally the *South Plaice* and the *North Plaice*, are geographically separated by the 56° N. L. approximately. The great mass of the North Sea plaice belong to the *South Plaice*; its region is the southern and south-eastern North Sea south of the Dogger Bank, perhaps including this; its main spawning-grounds lie in the south-west off the English Channel and further east between 54° and 55° N. L. The *North Plaice* have their region essentially north of the Dogger Bank, off the coasts of North England and Scotland on the one side and off the coasts of North Jutland on

the other side, with inclusion of the Northern Kattegat; the principal spawning-grounds of this race lie in the Moray Firth, on the Great Fisher Bank, in the Skager Rak and Northern Katttegat. The differences between the North and South Plaice consist in general of the following; the average number of vertebrae and fin-rays are lower in the former than in the latter and especially, the North Plaice has on an average a greater length at all stages than the South Plaice and is thus distinctly a more rapidly growing race. This last difference is of considerable importance; so far as the available, trustworthy determinations of age go, the plaice of the same length are on an average about half a year, better perhaps half a growth-period, younger in the northern North Sea than in the southern. During the first 4 to 5 years of life, when the growth in length of the plaice is absolutely the greatest, this would make a difference of several centimetres in the average length of a year-group, for example, of the third. In any case this difference in the rate of growth between South Plaice and North Plaice is considerably greater than the corresponding difference between the smaller, slowly growing males and the larger, rapidly growing females — a difference that is about 1 to 2 cm. in the first few years of life (46).

Although this question of the existence of different local races of the plaice in the North Sea has not yet been definitely solved scientifically, yet in forming any judgment about the composition of the plaice stock, we must seriously consider the probability of the existence of such races. All the more, since it is clearly of great importance for all practical questions regarding the plaice fishery, how rapidly the plaice grows and whether the one race grows in any way more rapidly than the other.

2. Subdivision of the North Sea into areas.

For a proper discussion of the scientific and practical aspects of the plaice question, a subdivision of the whole North Sea region into a number of larger and smaller areas is indispensable. Our choice of these areas must be determined by considerations of three different kinds. *Firstly*, they should be so chosen and defined, that it will be possible for the fishery statistics collected at the ports of entry to indicate with least error the area in which the plaice landed have actually been caught. *Secondly*, the position and boundaries of the different areas must stand in the closest relation to the general distribution of the plaice in the North Sea and the distribution of its various age-groups, as displayed in the preceding section. *Thirdly*, the selected subdivision of the North Sea should be international, that is, used as far as possible in the same way by all the participating countries.

From the practical standpoint it seemed expedient in the beginning to make use of the long-known, principal fishing grounds of the North Sea as a basis for the subdivision into areas. The Heligoland Ground, Borkum, Silver Pit, Dogger Bank, Clay Deep, Barren Ground, southern and northern Mud Bank, Horns Reef, Jutland Bank, Small and Great Fisher Bank, Long Forties, Fladen Ground etc. are the most important fishing grounds of the North Sea; they are not only well known to all fishermen, they are also biologically distinct and to some extent natural regions of the North Sea, both from the character of the bottom-soil and their fish population. In the first place,

however, the boundaries of these fishing grounds are not sufficiently well-defined to permit of the localization of the catches of the fishing-vessels without great errors and in the second place, they are too little suited to the special conditions of the distribution of the plaice. This original subdivision has therefore been given up in favour of the sharper definition of the areas which is necessary for our purpose.

In Scotland, on the proposal of FULTON, the North Sea has been subdivided in a purely geographically manner, in order to have the boundaries as sharp and clear as possible. Beginning from 63° N. L., FULTON (47) divides the whole North Sea into 48 approximately equal and rectangular areas, each extending over one degree of latitude and two degrees of longitude. However excellent this subdivision may seem at first sight for an exact determination of the locality of the catches landed at fishing-ports, and on the whole really is, the number of areas is too large for a convenient treatment of the distribution of the plaice and the results of the plaice fishery; it is necessary in fact to unite them into larger groups. On the other hand, this subdivision pays no attention at all to the natural lines of the bottom of the North Sea, nor to the special conditions of the plaice population.

In his report on the distribution of the plaice GARSTANG (48) starts essentially from a biological standpoint in his subdivision of the North Sea and Kattegat into areas. He marks off 100 different areas in the North Sea, grouped together in about 10 larger regions. These areas of GARSTANG agree very well in part with the natural, physical and biological conditions of the fishing-grounds, but they could only be used with success in such large number, because GARSTANG based his account of the distribution of the plaice exclusively on the scientific hauls of the research-steamers. These could easily and with certainty be included in the network of his numerous areas, as the place and time were accurately known. Naturally, however, this method of subdivision fails entirely when it is a question of representing the place of capture of the plaice landings of the markets.

A fourth and last proposal for the subdivision of the North Sea into different areas was laid before the International Council in Copenhagen in July 1905 (49), accepted by the Council and recommended as basis for the biological and statistical investigations on the plaice. This method, which is also used in the present Report, divides the North Sea in the first instance into 7 zones of depth: A-B-C-D-E-F-G; of these the first 5, beginning with a depth of 0 m. and taking progressively 20 m. for each zone, extend out to a depth of 100 m.; the last two F and G embrace the zones from 100 to 200 m. and over 200 m. Owing to the well-known bathymetric conditions of the North Sea these zones follow one another in general in the direction from south to north. Further, each of these depth-zones is subdivided from west to east, thus, for example, the A zone from 0 to 20 m. into the four successive areas from west to east: A_1-A_2-A_3-A_4; similary the B depth-zone from 20 to 40 m. into the areas B_1-B_2-B_3-B_4-B_5 and so on, as represented on the accompanying Chart.

This subdivision of the North Sea (50), which has already been used for some time in the English fishery statistics, best fulfils the requirements of such a subdivision, especially in connection with the plaice. Firstly, it agrees excellently well with the general law of distribution of the plaice in the North Sea; just as size and age increase proportionally to the depth, the areas A, B, C, etc. are arranged progressively in

relation to the depth and distance from the coast and the further subdivision of the 7 main areas into districts takes account of the natural difference in the distribution of the plaice, which exists between the western and eastern North Sea. Secondly, several of these areas correspond in their position and partly also in their boundaries with known fishing-grounds of the North Sea or groups of similar fishing-grounds lying near each other. Thus, B_1 is practically the Dogger Bank, the area C_3 contains the principal grounds of the plaice fishery from Lowestoft and at the same time the main spawning-ground of the plaice in the southern North Sea. Thirdly, it has proved, that the place of capture of the landings in the fishing-ports can be represented quite well in these areas without any great error. This is simplified on the one hand, by the fact, that the areas are distinguished by different depths and the fishermen note down the depth where they are fishing as a rule, on the other, owing to the areas being not too numerous and not too small; it is obvious, that the arrangement of the catches into the different areas will be the more accurate in general, when these are few in number and large.

A brief description of each area from the standpoint of the biology of the plaice and the plaice fishery will be useful for all further discussions.

1. *The A areas or the coastal regions of the North Sea*, from 0 out to 20 m. and with an area of about 13,000 square miles, are the dwelling-places of the young plaice fry and young, immature plaice of the first to third year; here we find the principal young-fish grounds of the plaice. They include the region of the greatest destruction of undersized plaice and the plaice landed amount to more than 50 % of the total weight of all the fish trawled (51).

A_1 (about 3,100 square miles) is a narrow zone along the coast of England from 50° N. L. as far as the Channel, which widens out off the Humber, Wash and Thames. The plaice fishery here is comparatively unimportant and is mostly carried on only by the smaller fishing-vessels.

A_2 (4,800 square miles) is a broader zone than A_1, lying off the Belgian and Dutch coasts from the Channel to Borkum. Here there is a fairly considerable plaice fishery with the beam-trawl, carried on mostly by the smaller fishing-vessels of Belgium and Holland. Almost 90 % of the quantities taken are "*small*" Plaice.

A_3 (4,800 square miles) is still broader than A_2. The true coastal zone of south-eastern North Sea (German Bight) from Borkum as far as 56° N. L., north of Horns Reef. Here there is a relatively very considerable plaice fishery, carried on not only by Danish fishing-vessels with the "snurrevaad", but also by German sailing-vessels fishing with the otter-trawl and by German and English steam-trawlers. Here also, at least 90 % by weight of all plaice caught and landed belong to the class "*small*".

A_4 (250 square miles) is a very narrow zone off the Jutland coast from 56° N. L. as far as the Skager Rak. The western part of the Limfjord also belongs to this area, both biologically and practically. This area is probably to be considered a young-fish region of the North Plaice, which however in the Limfjord, thanks to the legal protection of undersized plaice which has ruled there for a long time, yields a relatively large quantity of medium plaice from 26 to 40 cm. in length.

2. *The B areas* (from 20—40 m., containing 32.000 square miles) constitute the region of the North Sea, from which both in number and weight absolutely the largest

quantities of plaice are landed from the North Sea; more than 50 % of the total quantity from the whole North Sea (52). They are consequently by far the most important grounds of the plaice fishery and all lie south of a line, drawn from about Flamborough Head round the north edge of the Dogger to the Skaw. The product of the plaice fishery here composes about 25 % of the total weight of all the fish trawled. Biologically, we may call the B region the zone of the medium plaice from the fourth to sixth year. The subdivisions of B are in other respects very different from one another.

B_1 (6,800 square miles) is the Dogger Bank, one of the most natural, best known and richest fishing-grounds of the North Sea; it is a bank-like elevation in the middle of the North Sea, with fairly uniform, sandy soil, more or less sharply defined and wholly surrounded by deeper water. Corresponding to its central position and distance from the coast this Bank, though shallow in depth, shelters mainly the large plaice, which are caught here in very considerable quantity. Very remarkable also from a biological standpoint are the facts, that extremely small quantities of "small" plaice live on the Dogger Bank (only about 3 % of the total quantity in the catches) and that practically no eggs of plaice are found there in spite of the large quantity of ripe plaice occurring. Thus, B_1 is distinctly a feeding ground but not a spawning ground for the older plaice.

B_2 (5,900 square miles) lies off the east coast of England south of 54° N. L. as far as the Channel and in the east to a little beyond 2° E. L. The bottom is very irregular, with numerous narrow elevations (banks) running parallel from south-east to north-west with shallow water over them, e. g. Swarte Bank, Leman Bank, and deep channels between; in the north the Well Bank consists mostly of rough and stony ground. Here considerable quantities of plaice are taken by steam-trawlers and especially by sailing-trawlers, chiefly the large and medium-sized plaice; in this respect B_2 resembles B_1, though, on the other hand, the percentage of smaller plaice in the catches is here considerably greater than on the Dogger Bank, about 27 %, and there is certainly more spawning in B_2 than in B_1.

B_3 (10,700 square miles) is the broad, central part of the southern North Sea between the Channel and 54° N. L. and as far east as Borkum Reef; its boundaries towards B_2, A_2 and B_4 are not sharp and natural. The area embraces a series of the most important and best known, though heterogenous fishing-grounds, as the Hinder grounds in the south, Leman Ground in the north-west, Brown Bank in the middle, Texel, Terschelling and Borkum grounds in the east. The bottom consists mostly of fine sand with shells, in the north also of mud.

In extent the largest subdivision of the southern North Sea, *this area is economically the most important of all the areas for the plaice fishery,* producing by weight more than one-fifth of the total plaice landings from the North Sea, thus more than any other area; only area C_2, which is still larger in extent, gives approximately the same amount. Relatively also, by comparison with the catch of other trawl-fishes, B_3 is the principal plaice area, as more than 50 % by weight of the total catch consists of the plaice alone. More than 40 % of all the plaice landed from here belong to the class "small". B_3 is also *the main region of the plaice fishery by sailing-vessels,* which come here from England, Belgium and Holland and take away a larger amount of plaice than the steam-trawlers. Biologically, this area may be called the typical B area, that is, the

region of the medium-sized plaice; at the same time, next to C_3, it is the principal spawning-ground of the southern North Sea.

B_4 (6,300 square miles), extending from Borkum Reef in the west to the northern Horns Reef in the east, includes the deeper, mostly sandy, fishing-grounds of the German Bight of the North Sea, the Heligoland Ground and the outer grounds of Amrum, Sylt and Horns Reef. Though the plaice by comparison with the other food-fishes caught by trawl is not so important here as in B_3, the catch of plaice being only about one-third by weight of the total taken by the trawl, yet the absolute quantity of plaice landed from B_4 is very considerable and is only exceeded by that from B_3 and C_2. The characteristic of this area is the extremely great preponderance of "small" plaice, which by weight compose about 75 % of the total landings, and correspondingly the very small quantity of "large" plaice. In this respect B_4 is only surpassed by A_2 and the neighbouring coastal area A_3. These two areas A_3 and B_4 can scarcely be distinguished practically; both together constitute the region of the North Sea, in which the "*plaice question*" is of the greatest importance and in which occurs the greatest destruction of undersized plaice. The plaice fishery here is taken part in by England, Germany and Denmark, the first exclusively with steam-trawlers, Germany with steam and sailing trawlers, but mainly the latter, and Denmark almost exclusively with sailing-vessels, Biologically, B_4 must be regarded as the area of the "small" plaice; consequently, it is of subordinate importance as a spawning-ground.

B_5 (2,800 square miles) is the northernmost of the B areas, extending from 56° N. L. as far as the Skager Rak and embracing the fishing-grounds of the Jutland Bank; in its northern part it consists frequently of rocky ground, which is not suited to trawling. The plaice fishing here is relatively of little importance and is carried on by English and German steam-trawlers, but mainly by Danish sailing-vessels mostly from Esbjerg. The significant characteristic of the composition of the catches, especially of the steam-trawlers, is a distinct preponderance of the "small" plaice, though far from the same extent as in B_4. Biologically, B_5 probably belongs already to the region of the North Plaice and it may be a result of this, that the average length of the plaice in the landings is appreciably greater than in B_4. As a spawning-ground this zone is of no importance.

3. *The C areas* (from 40—60 m., 25,300 square miles in extent) are not so uniform as A and B and do not form such a large, connected region. The subdivisions C_1—C_2—C_3 are separate districts, scarcely touching one another and just as different in extent and size as in the physical nature of the bottom and the biological character of their fish population.

C_1 (5,700 square miles), corresponding to the steep slope of the sea-bottom on the west side of the North Sea, is a narrow belt along the English and Scottish coast, with three, widely separated, larger expansions; the *southernmost* and largest on the English coast off Flamborough Head between D_1, B_1 and C_2 and touching the last along a narrow zone at 2° E. L.; the *middle* expansion on the Scottish coast off the Firth of Forth, the *northernmost* in the Moray Firth (Smith Bank), both jutting out into the D region. By comparison with their small size, the plaice fishery in these areas, so far as it is not forbidden, as in the Moray Firth, must be regarded as not unimportant. The significant characteristic of C_1 in regard to the composition of the plaice landings,

is the extremely great decline in the quantity of "small" plaice by comparison with the medium and large; in this respect C_1 surpasses the other two C areas and shows a great resemblance to the Dogger Bank (B_1) and the deeper parts of the D areas.

C_2 (11,700 square miles) is the large, central zone of the North Sea, with bottom-soil mainly of very fine sand or mud. It embraces a series of the best-known and most important fishing-grounds, which differ widely from one another, as the Silver Pit, Scruff and Barren Ground, Clay Deep, Oyster Ground, White Bank, south and north Mud Bank, Little Fisher Bank. Along with the area B_3 and coming next to it, C_2 is the principal ground of the plaice fishery by steam-trawlers (of England and Germany), whereas in B_3 the sailing-trawlers preponderate. With respect to the relative importance of the plaice fishery in proportion to the total trawl-fishery, C_2 is naturally far inferior to B_3, the weight of plaice caught here being only about 11 % of the total catch by trawl, against 50 % in B_3. Corresponding to the greater depth and distance from the coast, the percentage of "small" plaice in the catches is much lower than in B_3 and still lower than in B_4; it amounts only to about 24 % against 40 % in B_3 and 75 % in B_4. As a consequence of this the density of the plaice population is also distinctly less than in the A and B areas (with exception of B_1 and B_3). Biologically, this area may probably be regarded as the region of the spawning, mature plaice of the south-eastern North Sea; pelagic plaice eggs have been found in fairly large quantity over wide stretches of this area, especially on the southern boundary towards B_3 and B_4 and beyond.

C_3 (1,800 square miles) is a small area but well-defined physically and biologically and subject to a very intense fishery; it lies in the south-western North Sea between the areas B_2 and B_3. Owing to the rough ground at many places the trawl-fishing is mostly carried on here by sailing-vessels with the beam-trawl, chiefly from Lowestoft and in the winter months. In proportion to the very small extent of the area the intensity and product of the fishery are extremely great, particularly with regard to the plaice, which contributes by weight almost half the total quantity taken by trawl. The total weight of the plaice landings from C_3 amounts to about one third of that landed from B_3 and C_2, though each of these areas is from 6 to 7 times as large. The significant characteristic of the composition of the plaice landings from this area is, that the larger plaice certainly exceed the smaller in weight, as in the area C_2, but yet that relatively very considerable numbers of small plaice occur. Biologically, this may be connected with the fact, that this area along with the neighbouring parts of B_3 forms the principal *spawning-ground* of the southern North Sea, towards which large quantities of mature plaice of all sizes probably gravitate, even from some distance, during the months of spawning.

4. *The D areas* (from 60—80 m.; 24,500 square miles in extent) represent the beginning of the deep region of the northern North Sea north of the Dogger Bank. They are divided by a broad intrusive tongue of deeper water from the north into a western and an eastern half, the former composing the subdivisions D_3 and D_1, the latter the area D_2. D_1 and D_3 lie near to the English and Scottish coast and include, among others, the grounds off the Firth of Forth, Aberdeen Ground, Long Forties and a part of the Moray Firth, and north from there. D_2 embraces the well-known fishing-ground, Great Fisher Bank, as also the North-West Flat and Ling Bank. All the D

areas are very rich fishing-grounds and support a considerable trawl-fishery, but the plaice is so unimportant here by comparison with other bottom-fishes, that it scarcely contributes 5 % to the total quantities taken by trawl. Nevertheless, the stock of plaice in the various parts of these areas is fairly considerable, especially on the Scottish coast. The "small" plaice constitute everywhere a very small proportion of the landings from these areas; the great majority consist of the medium and large plaice, the last especially in D_2, where they compose almost three-fourths of the total catch of plaice by weight. Biologically, we may call the D areas the region of the "large" Plaice. As spawning-grounds also, many parts of these areas, especially the Great Fisher Bank and the Moray Firth, are of some importance.

5. *The E, F and G areas* (80—100, 100—200 and over 200 m.; 16,500, 30,500 and 10,100 square miles respectively) are of very subordinate importance in the plaice fishery. The plaice landings from these areas amount altogether to not more than 5 % of the total catch of plaice and scarcely 1 % of the total catch of the trawl in the North Sea. The largest amount is contributed by the area E, which is a broad and deep tongue pushing down from the north into the middle of the North Sea to south of 56° N. L., especially by the western part off the Scottish coast and the northern part bordering on the area F. The quantity of plaice caught here decreases fairly regularly with increasing depth. The catches consist almost entirely of large and medium plaice; "small" plaice only occur, where the deeper regions approach very near to the coast, for example, off the north-east coast of Scotland and off the Orkneys and Shetlands. At various parts of this area, e. g. in the Moray Firth, at the Shetlands and on the Norwegian coast, the pelagic eggs of the plaice have also been found but in relatively small quantity.

3. Means and methods for determining the composition of the catches and stock of plaice.

The first and principal object of all investigations on the plaice question is to obtain an exact knowledge of (1) the composition of the actual stock of plaice in the different parts of the North Sea and at different seasons of the year, according to size, weight, age and sex, (2) the composition of the plaice landings at the fishing-ports, (3) the proportion in which the plaice stock and plaice landings stand to one another.

The only means of attaining this object is by analysis of the plaice catches in the manner described. We must distinguish between three, essentially different kinds of material.

1. *The scientific hauls of the research-steamers* and other investigating vessels. They are made with nets of very different kind and very different methods and power of fishing. Their analyses offer the only means of determining the composition of the true stock of plaice in the sea.

2. *The purely practical catches of the fishing vessels (fishery hauls).* These are made with the ordinary nets of the fishery. Their analyses reveal what kind of plaice, of what size, weight etc., are taken up by the fishery from the actual stock of plaice on the bottom of the sea.

3. *The plaice landings of fishing-vessels on the market* (*market landings*). Their analyses give us information with regard to the kind of plaice, class and relative quantity,

used for human consumption and indicate the product of the fishery and its economical value.

Experience has shown, that these three kinds of material, so far as the plaice is concerned, are in most cases essentially different from one another, even when obtained at the same time and from the same locality (53). For example, a scientific haul made in June on a certain fishing-ground near Heligoland with different nets, including small-meshed nets, obtains plaice from 5 to 40 cm.; a fishery haul, for example by a cutter, contains plaice from 10 to 40 cm. and the fish landed by it on the market only plaice from 17 to 40 cm. Further, the scientific haul may perhaps contain twice as many plaice as the fishery haul and the latter again twice as many as the market landing — or the differences may be considerably greater. It is evident, that these are produced, firstly, by the differences in the size of mesh in the scientific and practical nets; the former takes all the sizes present of the plaice, the latter makes a selection, as the smaller fish escape through the meshes (*net selection*). Secondly, by the fact, that the fisherman again makes a selection of the plaice actually caught, throwing the smaller overboard as worthless and only keeping the larger for the market (*market selection*). On the other hand, if there is no net selection, because no small fish are present, and also no market selection, because all the fish caught are saleable, then the scientific hauls, the fishery hauls and the market hauls made at the same time and spot would show no difference in their composition. This is the case, for example, on the Dogger Bank, where all three kinds of hauls in June contain plaice of the same sizes from about 21 to 65 cm., and in fact everywhere, where small plaice below 16 cm. in length do not occur or only in very small numbers, thus in the deeper and more distant parts of the North Sea.

The analysis of the different kinds of material will yield so much the better information, the greater the number of catches obtained for study. It is obvious without explanation, that the hauls which can be analysed and really are analysed, will always be merely single *samples* out of an enormous number. The scientific hauls give us single samples of the actual stock of plaice in the sea (*stock-samples*), the fishing-vessels samples of their actual catch (*catch-samples*), the market statistics samples of the plaice landed (*market-samples*). The question is, then, what is the relative value of these samples and how far can their composition be taken as typical for the total quantity under the special conditions prevailing, that is, in the ordinary sense how far they are "*representative*".

The *stock-samples* of the scientific research-steamers have certainly, as single samples, relatively the greatest representative value. The place, duration and all subsidiary circumstances of the hauls are accurately known; as regards composition they come quite unchanged and untouched into the hands of the investigator and their analysis can be made with the greatest accuracy. This advantage carries with it a disadvantage. These samples are not very numerous, are unequally distributed over the North Sea, and the number of plaice measured in them is very small in proportion to the enormous quantities landed by the fishery and the still greater quantity of plaice occurring in the North Sea. Up to the present time about 5000 scientific hauls and about 600,000 measurements of plaice have been made by the International Investigations. According to a rough calculation, this number amounts to about 1 per 1000 of the plaice stock

of the North Sea. Thus, for every million in the stock of plaice one sample of 1000 plaice is analysed on the average. From a purely numerical standpoint this would be sufficient, however, to make the samples representative. When we remember, that most of the scientific hauls containing the majority of plaice — certainly 90 % — are made in the shallow parts of the North Sea and just on the grounds, where a net-selection and market-selection occur, thus making the scientific hauls indispensable, we may conclude, that these samples made at the most important place form a larger percentage than the average 1 per 1000 of the stock there. And even in a few, more restricted localities, e. g. on certain fishing-grounds round about Heligoland — the so-called young-fish grounds of the plaice — the stock-samples certainly compose more than 1 %, sometimes even 10 to 20 % of the whole stock (54). These are, numerically, certainly representative.

The *catch-samples* of the fishing-vessels, owing to the enormous number taken at all times of the year, would be of extremely high representative value, if their analysis could be carried out practically to a sufficient extent. This is not the case. The fisherman himself is very seldom in a position to make the analysis of a haul immediately, even if restricted to the measurement of the plaice, and to take naturalists on board to make the analyses meets with the greatest difficulties practically. The important task of carrying out the analysis of the catch-samples thus devolves almost entirely on the scientific research-steamers or on fishing-vessels specially charted for this purpose, which thus become scientific vessels. The scientific stock-samples must therefore in great part serve also as catch-samples. As the number of hauls made yearly by the fishermen in the North Sea must be estimated at several, perhaps 5, millions, about 500 scientific hauls yearly would mean only 1 haul analysed in 10,000. This is too few, but still certainly not so few, that no value can be attached to these catch-samples. Here the number of catch-samples analysed should not be compared with the absolute number of all the hauls made during the year in the whole North Sea, but only with those hauls in which a selection of the catch is made by the fisherman and where the catch-samples are different from the market-samples. The number of these is considerably less than 5 millions, perhaps only the half or even less. For small restricted areas, e. g. the young-fish grounds of the areas A_3 and B_4 and B_3, and for certain seasons the number of analysed catch-samples also rises here to 1 % and more of all hauls with the trawl and their representative value must be placed at a high level.

The *market-samples* in the fishing-ports can readily be analysed in much greater, absolute numbers, and are so as a matter of fact, than the stock-samples and catch-samples, and in this lies their high representative value. The great difficulty here is the right selection of the samples. In the case of the stock-samples and catch-samples of the scientific research-vessels there is no selection of samples, since each single haul is analysed completely. In the fishing-ports it is quite different. Here the landings of the different steam-trawlers and sailing-vessels almost never — in fact only when the plaice are landed *living* — come into the hands of those who analyse them in their original mixture and composition when the fish were taken. The fisherman, on bringing his catch of plaice to market and often already out at sea, *sorts out his catch* for the purpose of convenient sale and rapid and correct estimate of its value, that is, he divides the plaice into the *ordinary classes* of the port he lands at (large, medium, small etc.),

The investigator of the market-samples has thus to be content with the boxes or baskets of these different classes and it is thus necessary to reconstruct the composition of the original mixtures from the analysis of the different market-classes. For this purpose it would be best to take the landings of each fishing-vessel separately, but in very many cases, especially in the large, English fishing-ports, this is not possible, as the samples from the different vessels have already been mixed by the fish-dealer or salesman, at whose place the measurements must be made. In this case the only thing to do is to select and unite together the samples of the different classes to be measured, which are to represent for example one month and one definite fishing-ground, in order that the quantities by weight of each class may be as nearly as possible proportional to the corresponding total quantities by weight for that month and fishing-ground. And that is a very difficult task. Even where it is possible to analyse with sufficient accuracy the actual landings of some vessels, but at the same time impossible to do so for all the single landings — and this is naturally always the case — a careful selection must be made among the landings, which are in this way as good as analysed. These great difficulties in the way of a reliable selection of the market-samples reduce considerably their representative value. The possible errors in the composition of the quantities of plaice, landed, for example, in any one month and from a definite area, may certainly be very considerable and can only to some extent be eliminated, according to the laws of probability, by the investigation of a very large number of samples from different ports. Fortunately, we now possess — at least from two countries, England and Germany — such extensive series of measurements of so many, systematically selected market-samples, that we may consider the material as to some extent representative of the composition of the plaice landings in these two countries. In England (55) investigations have been made in *four* of the principal ports during the period from October 1905 to March 1909 and 24,462 boxes of plaice have been analysed according to size and weight, altogether 5,600,000 plaice in round numbers with a weight of 1,387,000 kg., which gives an average weight for each plaice of about 248 gm. The total quantity of plaice landed from the North Sea during this period by first-class vessels in English ports may be estimated at about 95,000,000 kg. or 380 million plaice. The market-samples analysed thus amount to about 1.5 % of the total quantity by number and weight. Taking all together, the number of plaice from the North Sea, which have up to the present time been measured on the fish-markets in all the different countries, is about 6,000,000.

A disadvantage in the market-samples by comparison with the stock and catch-samples is, that their *place of capture* cannot be determined with the same accuracy. Errors in this regard very greatly reduce their representative value. To eliminate this difficulty as much as possible, a careful sifting of the samples is again necessary, all those for which the place of capture is too uncertain, being discarded. And in order that these samples of uncertain origin may not be too numerous, the number of the fishing-grounds, or better fishing districts, distinguished in the North Sea, should not be too great. We may recall here what has been said in the previous section in discussing the areas of the North Sea (p. 25).

It will be sufficiently clear from the above, that the representative value of any samples will depend partly on their number, partly on their correct selection. I am of

the opinion, that both these moments, *number* and *selection*, are equally important and that too great importance has often been ascribed to the number. This has even gone so far, that the scientific hauls of the research-steamers have been denied all value for the judgment of the fish-stock in the sea, for the reason that they seem relatively insignificant in number by comparison with the enormous extent of this, and all stress and hopes in this direction have been laid upon the far more numerous, statistical investigations on the market. It is to be regretted, that this view has led to the scientific hauls of the International Investigations no longer receiving the same attention as the investigation of the market-samples, and, above all, has prevented the results of the scientific hauls being worked up and published in the manner requisite. We are thus, unfortunately, not yet in a position to make use of the large material of scientific hauls for this General Report in a manner corresponding to their high value.

The scientific stock-samples, so far as the representative value is concerned, are far superior to the market-samples, except in their smaller number. This representative value increases certainly with the magnitude of the number, but, what is often overlooked, by no means proportionally to this number, but only in proportion to its square root. Such values as the average length of the plaice in a certain area or the number of plaice there which have a definite length, e. g. 25 cm., are affected with some amount of uncertainty, which mathematically is called their *probable error*, and the magnitude of this is inversely proportional to the square root of the number of specimens examined. If, for example, we take 28.35 cm. as the average length of 5 millions of North Sea plaice landed and measured, the attribution of this average to the total number of North Sea plaice landed would have some amount of uncertainty, that is to say, a probable error, which for the moment we may take to be $\pm$ 0.02 $= \pm \frac{44.72}{\sqrt{5{,}000{,}000.}}$ If, now, the same average is obtained from 500,000 plaice instead of 5,000,000, thus only a tenth part, the probable error of the average, other things being equal (e. g. the same composition of samples in both cases), would be $\pm \frac{44.72}{\sqrt{500{,}000}} = \pm 0.06$. Thus, the uncertainty of the average value is now certainly greater than in the case of 5 million plaice, not ten times, however, but only *three times* greater. Conversely, an increase in the number of plaice examined, e. g. to 50 millions, would reduce the probable error, from $\pm$ 0.02 to $\pm$ 0.006, thus to a third of its first value. In such cases we have good reason for asking, how great must the representative value of the measurements be, or the certainty of the values calculated from them, to permit of conclusions regarding the plaice stock of the North Sea etc., which would be sufficiently accurate for our purpose. And the obvious answer is, that, for conclusions to be drawn from the statistical plaice measurements, it is fully sufficient if such values as the average length etc. are reliable to one whole centimetre (that is, if the probable error does not exceed this amount). And this amount of accuracy can be attained from a very much smaller number of measurements, such as we already have at our disposal from the scientific hauls.

As indicated above, it is not merely the large number of the market-samples which determines the representative value of the analysis, the degree of representativeness

depends just as much on a fair selection of the samples. The advantages of the large number may be quite nullified by the disadvantages of an imperfect selection, cases of which will be shown in the following parts of this Report. At all events, even in the case of the market-measurements, in spite of their large number, we cannot rely upon any greater certainty than one whole centimetre in the average values of the length; in many cases, however, even this degree of certainty is not attained. Reliance upon the certainty offered by large numbers may in such cases lead us to believe in a accuracy which in reality does not exist, owing to extensive errors in the selection of the samples, and which perhaps cannot be attained to. The numbers once obtained are fixed, unchangeable values, which may be subjected directly to mathematical treatment; the samples, on the other hand, are dissimilar, fluctuating dimensions and the errors in their selection it is often difficult or impossible to discover.

In all our conclusions, therefore, we must take into account the fact, that the mathematical certainty calculated from the values obtained from the analysis of the samples is always greater than that actually existing. An increase of the number above a certain degree or dimension is not of any real use. We must be statisfied with a lesser degree of certainty.

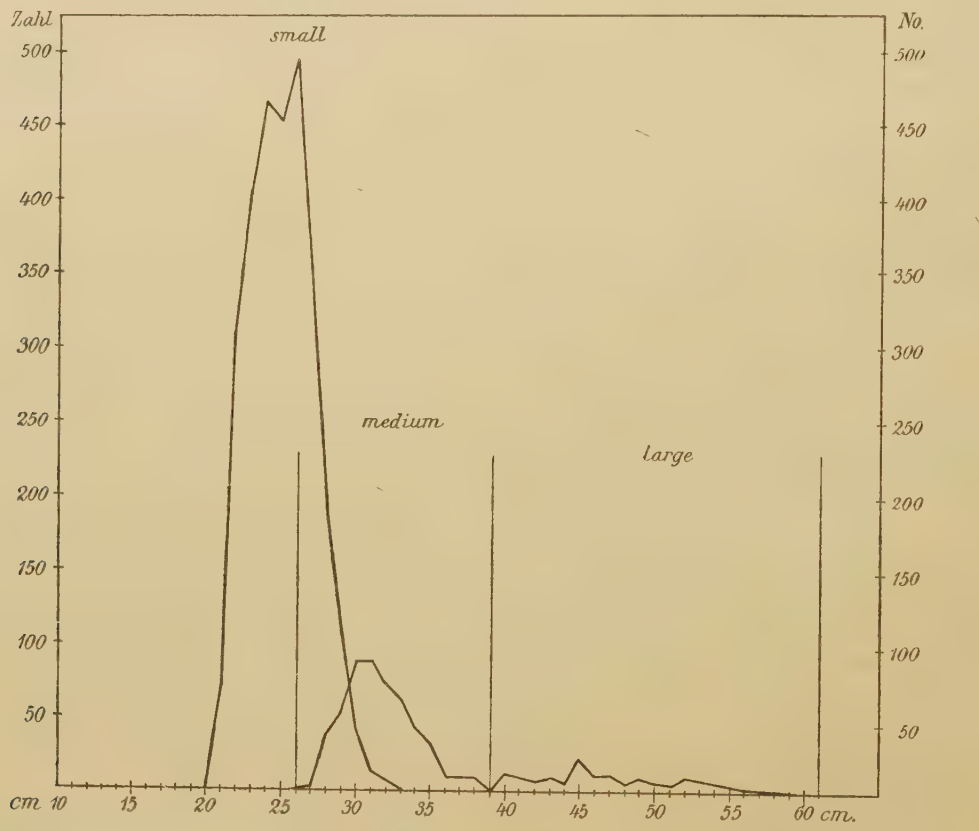


Fig. 2. Analysis by lengths of a market-sample of plaice from area B2, May 1906, sorted in Grimsby into 2904 small, 513 medium, 156 large. Absolute numbers (56).

General composition of the samples and their scientific treatment.

Every analysis of a sample of plaice, whatever its nature may be, according to length, weight or age, yields a series of numbers and, graphically, always a picture of an ascending and descending *curve (polygon)*, mostly with one maximum to the series, often also with two or more highest points (maxima). We never obtain a series only

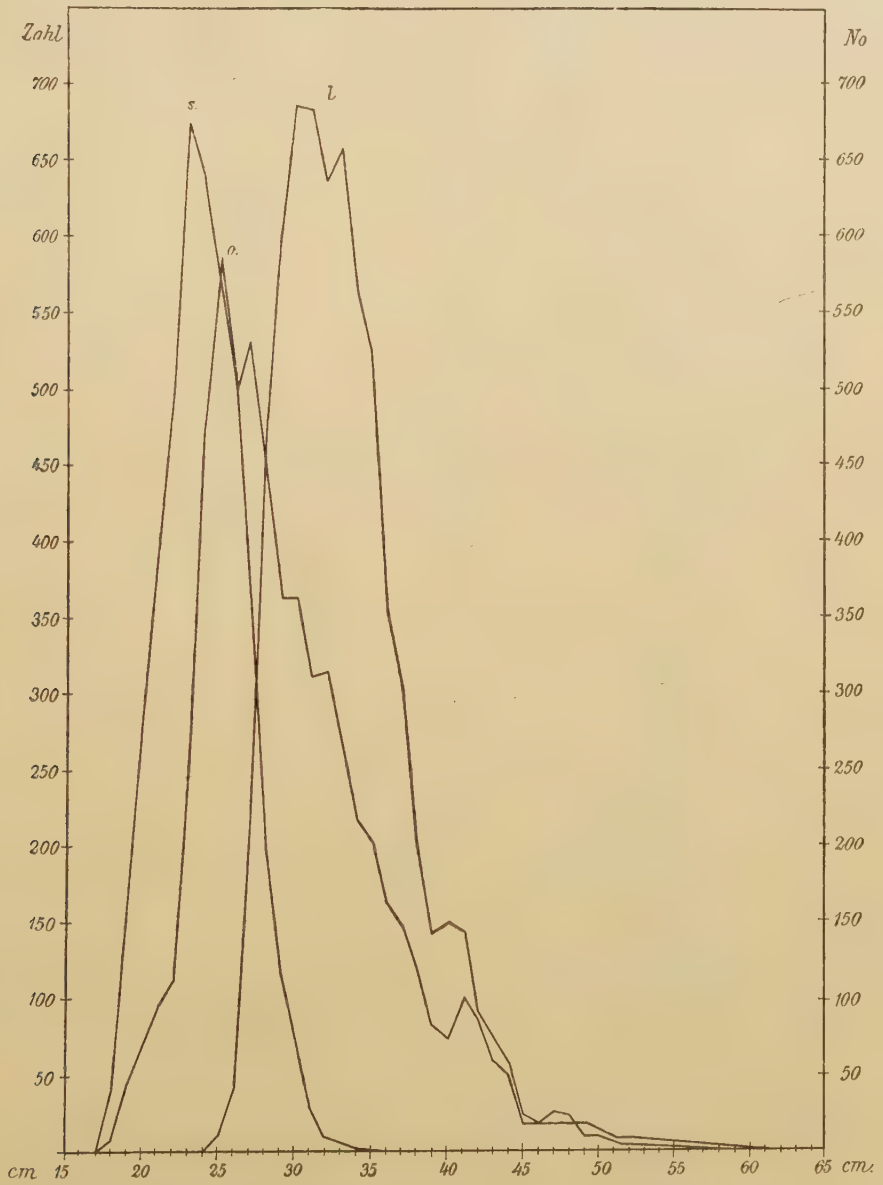


Fig. 3. Analysis by lengths of a sample of plaice from area Cs, February 1906, sorted in Lowestoft into 4547 small and 6787 large; 6167 unsorted "others". Absolute numbers (57).

rising or only falling between a lowest and a highest value. This is everywhere the *typical course* of the curves and may be exemplified here by one or two cases.

Analysis of market-classes. Figs. 2 and 3 show analyses of various samples of the ordinary market-classes, such as we find in the English ports of Grimsby and Lowestoft. In both ports the plaice have a length of about 20 to 65 cm.; in Grimsby these are sorted into the classes small, medium, large, in Lowestoft into small and large and others; the last are the unsorted plaice brought directly from the vessels for sale on the market. We see (1), that the method of sorting is quite different at Grimsby and Lowestoft, (2) that the plaice of each class are very different in size and are

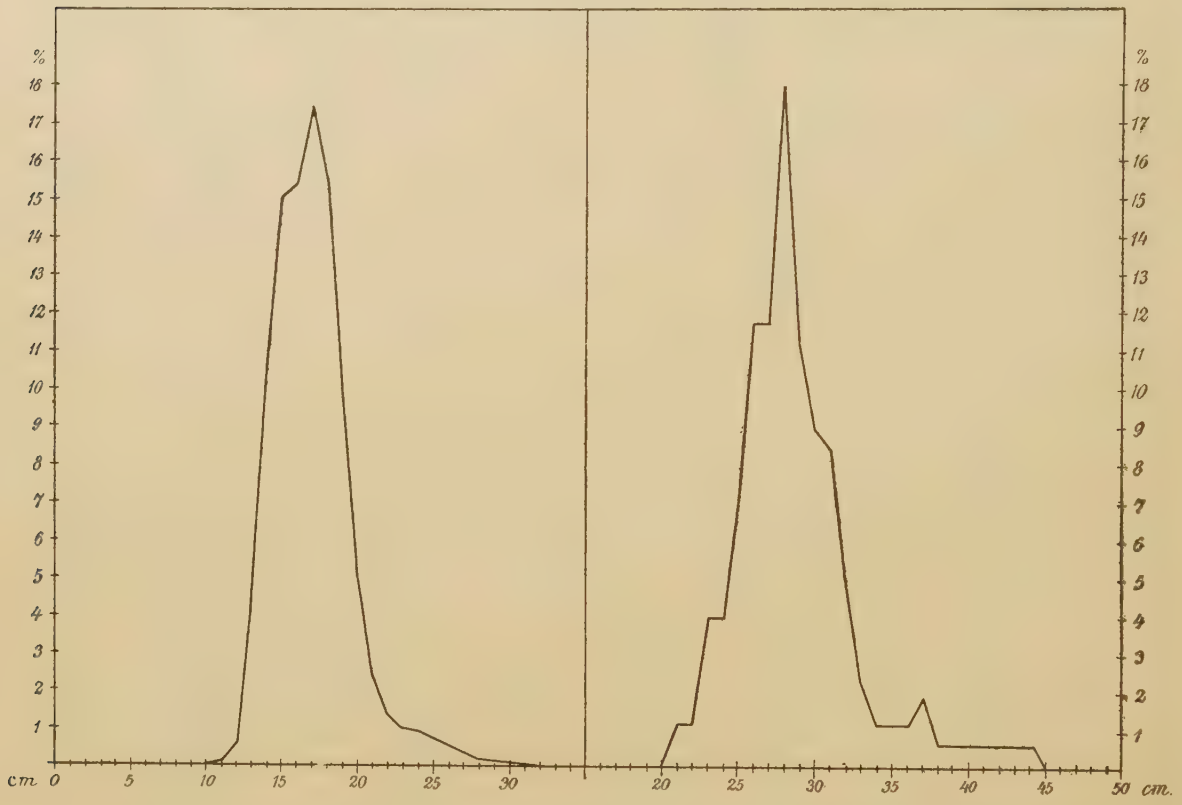


Fig. 4. Analysis by lengths of a catch of plaice by the "Poseidon" on area A_3 (Borkum Ground), July 1908. 3351 plaice in 2 hours (1675 per trawling-hour). Maximum of the curve at 17 cm. — Percentage curve (58).

Fig. 5. Analysis by lengths of a catch of plaice by the "Poseidon" on area C_2 (Southern Mud Bank), October 1902. 179 plaice in $2^1/_2$ hours (72 per trawling-hour). Maximum of curve at 28 cm. — Percentage curve (59.)

grouped about one, two or several maxima, (3) that the curves of the different classes overlap one another more or less and (4), that the range of variation, i. e. the distance between the two extreme values of a series, is very different and greater in the "large", than in the "small", and greater in "others" than in the other classes.

Analysis of catch-samples. Figs. 4 to 8 represents some analyses of catches with

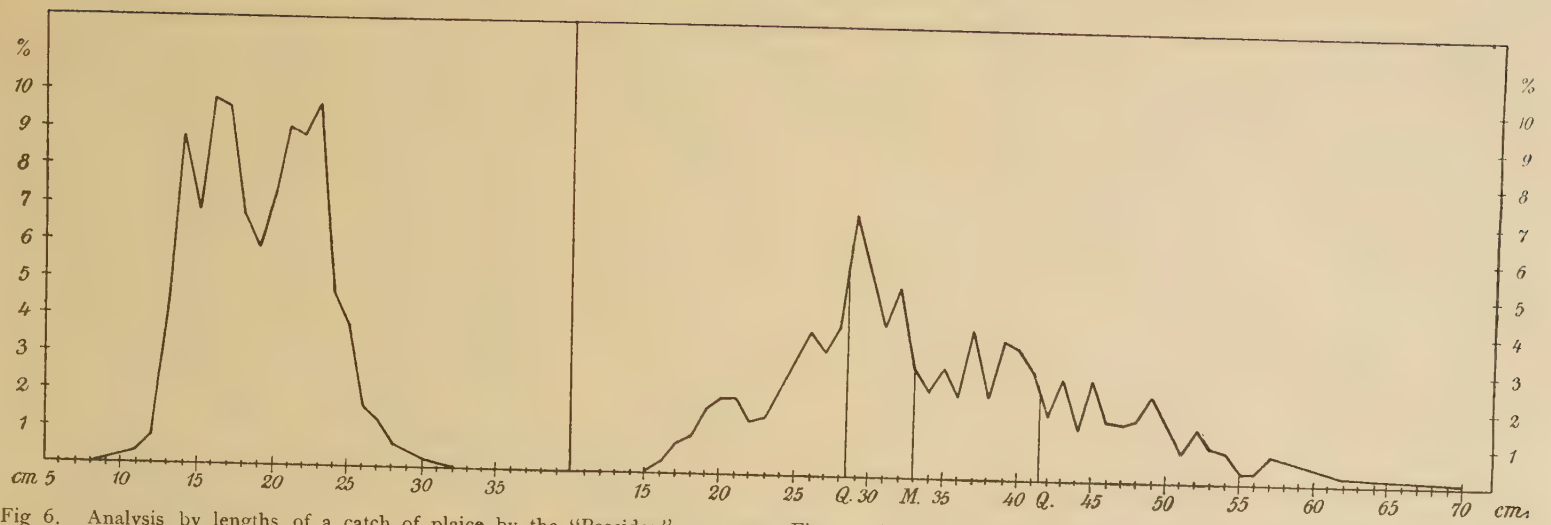


Fig 6. Analysis by lengths of a catch of plaice by the "Poseidon" on area B_4 (Sylt Ground), March 1903. 1546 plaice in 5 hours (309 per trawling-hour). 3 principal maxima at 14, 16 and 23 cm. Range of variation from 6 to 34 cm. — Percentage curve (60).

Fig. 7. Analysis by lengths of a catch of plaice by the "Poseidon" on A_3 and B_4 (partly also C_2), January 1904—07. 857 plaice in 81 hours (10 per trawling hour). Principal maximum at 29 cm. Subsidiary maxima at 20, 26, 32, 37, 39, 45, 49 cm. etc. Range of variation from 10 to 70 cm. — Percentage curve.
M position of the median.
Q Q the two quartiles.

the trawl by research-steamers ("Poseidon") in different areas and at different seasons of the year. Fig. 4 is a typical picture of a summer catch on the young-fish grounds of the plaice (area A_3, Borkum Ground), where there is a very great density of small plaice (over 1600 per trawl-hour); the series has a small range and thus a crowding of the different sizes about a length of 17 cm. Fig. 5 is similar, but more irregular and with signs of several smaller, subsidiary maxima; it represents an autumn catch on an area much further out to sea (C_2); the plaice are much larger on an average but their density is less (only 72 per trawling hour). The principal maximum of the curve lies at 28 cm.

Figs. 6 and 7 also represent catch-samples, but from a different season of the year and, in obvious connection herewith, with an essentially different composition. Such *winter-hauls* are characterized by a wider range of variation and an irregular form of curve, which almost always shows more than one, often three, four and more maxima separated by depressions, thus a very unequal distribution of the various sizes of the plaice.

Comparison of catch-samples with market-samples. Fig. 8 gives together and on the same scale the curves of a catch-sample (A) and of a market-sample (B), from the

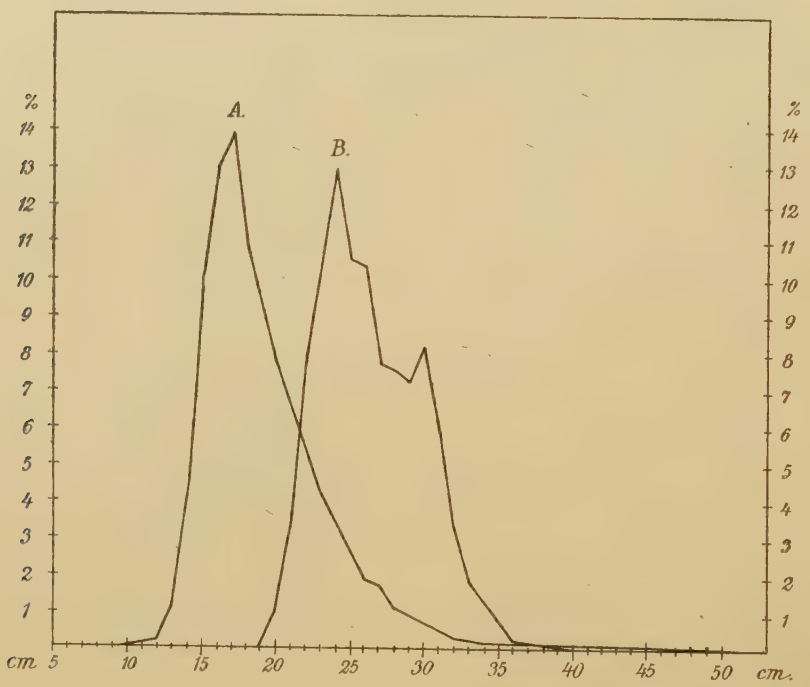


Fig. 8. Analysis by lengths of a catch-sample (A) of the "Poseidon" and of a market-sample (B), September 1907 from area B_4. — A 15,483 plaice, taken with the ordinary trawl in the neighbourhood of Heligoland. B 12,577 plaice, measured in the ports of Grimsby, Lowestoft and Boston. Maximum of A at 17 cm.; maximum of B at 24, subsidiary maximum at 30 cm. — Percentage curves (62).

same season (September 1907) and the same area B_4; both contain numerous and approximately the same amount of plaice and may claim some representative value.

It will be seen from a comparison of the two curves, that of the plaice present on the area B_4 in September and actually taken by the ordinary trawl only a fraction, perhaps 30 %, are kept in the market-sample and landed, whilst the greater part, about 70 %, are picked out by the fishermen and thrown overboard.

Analysis according to length and sex. Fig. 9 shows an analysis of German market-samples according to length and sex. It will be seen, that the males at each size are more abundant than the females up to a length of about 25 cm.; after that the condition is reversed and the females become more abundant than the males.

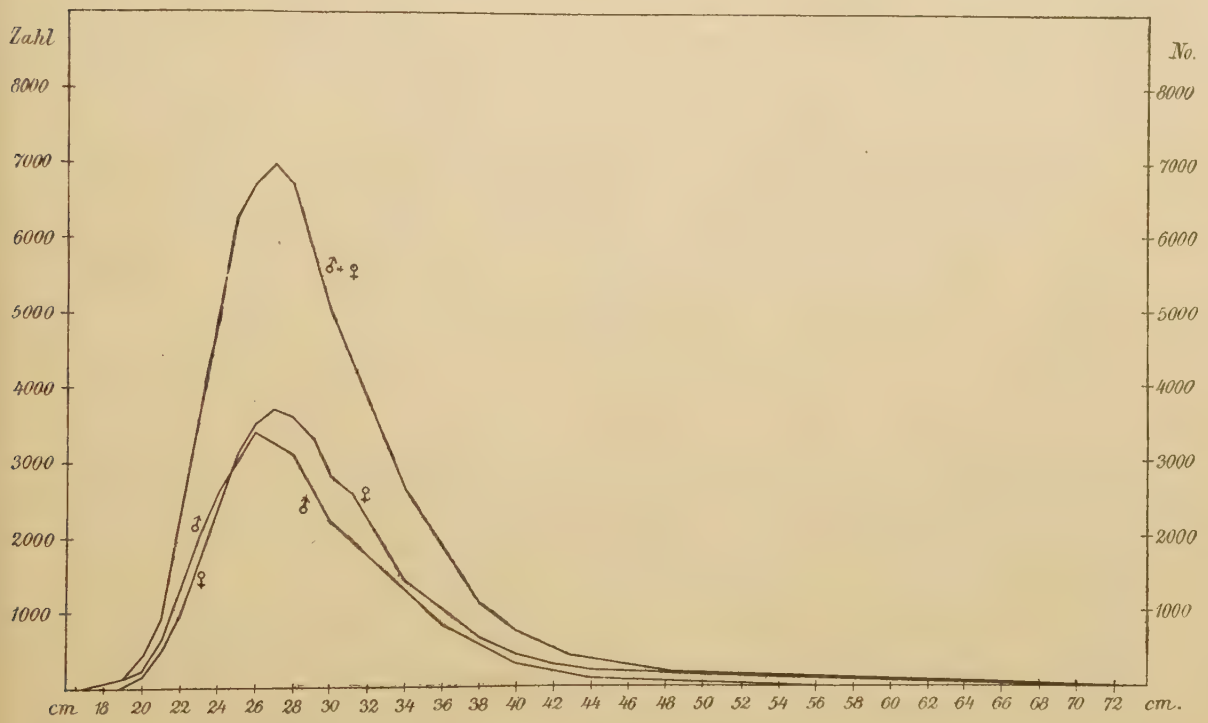


Fig. 9. Analysis of all plaice landed in German ports from the area C_2 in the year 1909, by length and sex. 35,344 ♂ + 41,791 ♀ = 77,135 plaice. Total curve and curves for ♂ and ♀ separately. Crossing points of the ♂ and ♀ curves between 24 and 25 cm. — Absolute numbers (63).

Analysis of samples according to length, age and sex. Fig. 10 represents the analysis of a catch-sample according to length and age, determined by the number of rings on the otoliths. The curve of lengths has a principal maximum at 19 cm. and three subsidiary maxima at 14, 21 and 26 cm. The catch is composed of the three year-groups I, II, and III, of which II contributes the greater portion. The maxima of the three age-curves 1, 2 and 3 correspond in their position to the three maxima on the length curve at 14, 19 and 26 cm. The analysis shows (1), that several year-

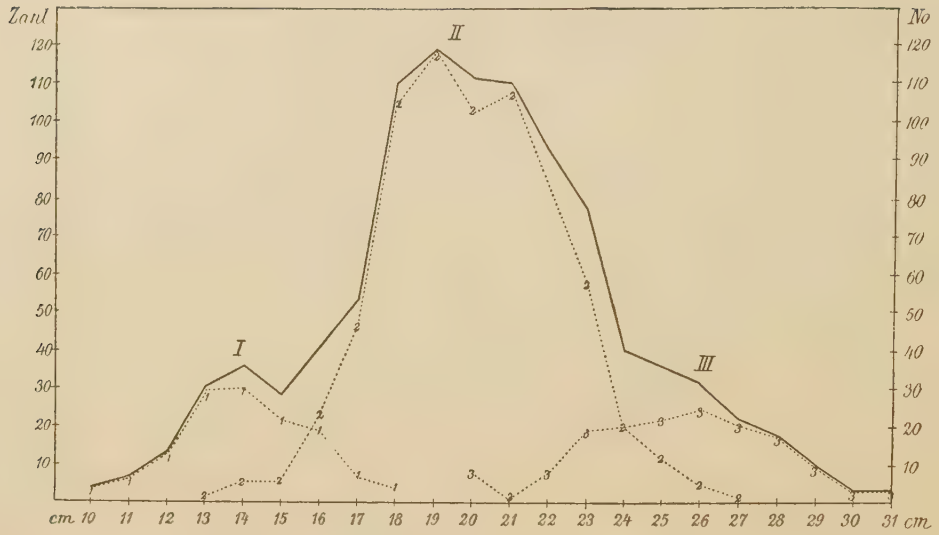


Fig. 10. Analysis of a catch-sample of the "Poseidon" from area A 3 (Sylt Inner Ground), 19th March 1904, according to length and age.

995 plaice ——————— curve of lengths.
135 » ..... 1 ..... 1 ..... } curves of age } with 1 otolith ring, I group, in second year
698 » ..... 2 ..... 2 ..... } » 2 » » II » » third »
162 » ..... 3 ..... 3 ..... } » 3 » » III » » fourth »

groups may occur together in one haul, here with the predominance of a certain year-group; (2), that plaice of the same age may have very different lengths and that the length-curves of successive years overlap one another; (3), that multimodal curves may arise from the mixing of several year-groups at one place.

Fig. 11 represents an analysis of a group of plaice of the same age and shows, that the males are on an average smaller at the same age than the females (principal maximum of the two sex-curves at 19 and 20 cm. respectively). Similarly, fig. 12, which represents the analysis of a group of North Sea plaice of the same length (25 cm.), shows that these plaice may belong to very different year-groups, here to as many as 7 successive year-groups, the great majority however to a few, here 3 year-groups (groups II to IV); the curve shows, further, that the males are on an average somewhat older than the females at the same length.

Analysis of samples according to length and weight. Relation between length and weight of the plaice. For many important purposes of our investigations it is necessary to determine not only the size (length in *centimetres*) of the plaice, but also their weight (in *grammes*). It has proved, that these two factors, length

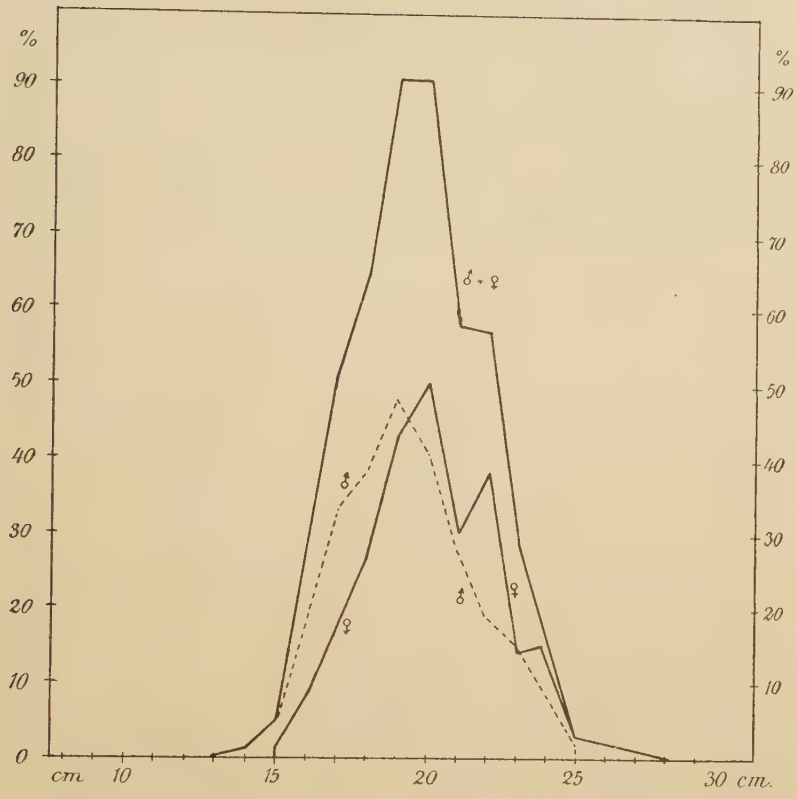


Fig. 11. Analysis of 494 plaice in the third year (II group), from the neighbourhood of Heligoland, September 1905, according to length and sex. 248 ♂ and 246 ♀. Absolute numbers (65).

——— curve of ♂ + ♀
——— » » ♀
..... » » ♂

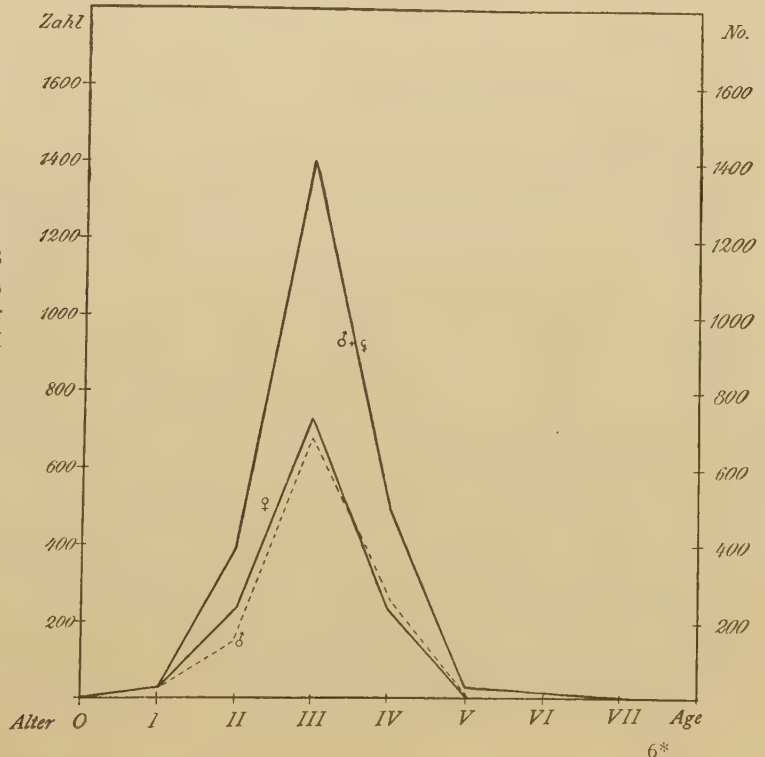


Fig. 12. Analysis of 2339 plaice (1228 ♂ 1111 ♀) of 25 cm. in length, from the North Sea, according to age, number and sex. Absolute numbers (66). O-I -II------VII age-groups.

——— curve of ♂ + ♀
——— » » ♀
. . . . » » ♂

and weight, stand in a simple, numerical relation to one another. As fig. 13 shows, the separate weights of a number of plaice of the same length (e. g. 20 cm.) selected from a sample vary very considerably; in the first sample (A) given here, from 66 to 89 gm., with an average weight for all of 76.4 gm.; in the second sample (B) from 75 to 110 gm.; in both together from 66 to 110 gm. It is evident from these curves, that plaice of the same length may have a very different weight at different seasons of the year. Plaice of 20 cm. in length weigh here on average 76.4 gm. in May, and in September 89.8 gm. on an average. The September plaice are at the

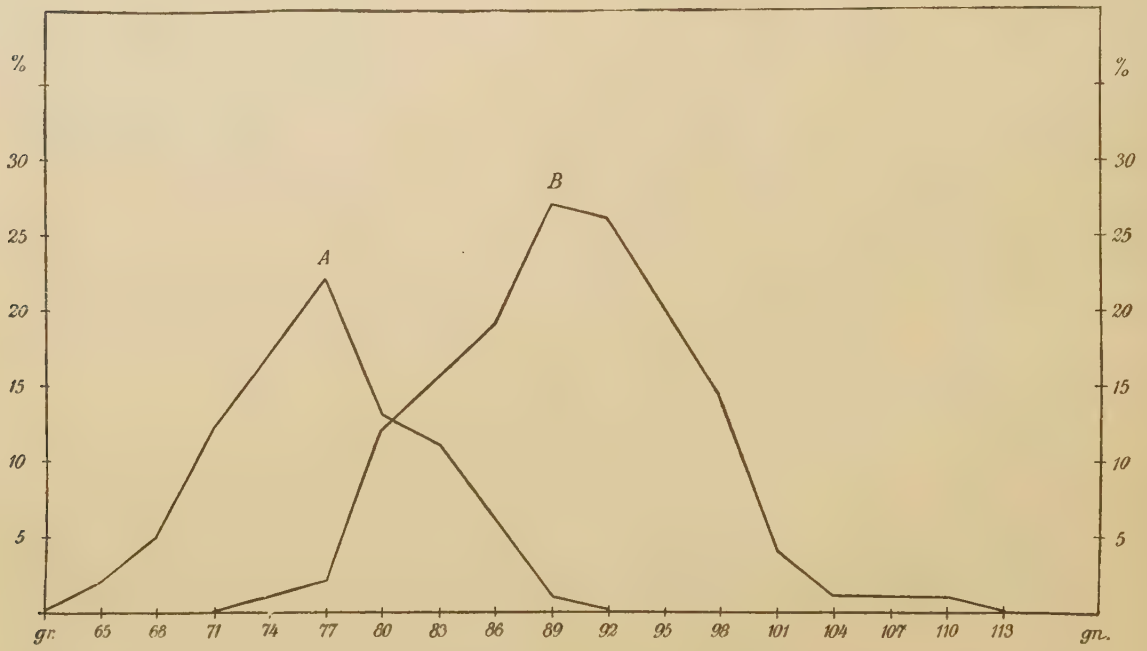


Fig. 13. Analysis by weight of two samples of plaice of one and the same length (20 cm.); one sample (A) containing 89 specimens from the Sylt Inner Ground, May 1906; the other sample (B) containing 144 specimens from Heligoland, September 1905. Average weight of A 76.4 gm.; of B 89.8 gm. Percentage curves (67).

same length thicker, speaking generally, in better condition, than the May plaice. The average weight in gm. (w) of a number of plaice of the same length in cm. (l) and from the same place and time stands in the following, simple relation to the length:

$$w = \frac{l^3}{100} \cdot k$$

where k is a constant. This relation varies, however, in part according to the condition of the plaice, i. e. the season of the year, in part according to the absolute size of the plaice and in such a way, that k, so far as the condition of the plaice is concerned, is smallest at the end of the winter and at the end of spawning, greatest at the end of the yearly period of growth, in September to November. Further, other things

being equal, k increases, though to a less degree, the greater the absolute length of the plaice. In this way k varies in the case of the plaice from about 0.80 to 1.20 and amounts to about 1 on an average for all months and all sizes. When $k = 1$, the average weight of plaice 20 cm. in length (instead of 20 cm. we must take 20.5 cm., as all lengths between 20.0 and 20.99 are taken as 20 cm. according to the international arrangement), would amount to 1 per cent of the third power of 20.5, thus to 86 gm. in round numbers. The average weight calculated from the curve A for May, namely 76.4 gm., would thus give $k = 0.88$, the average weight from the curve B for September, namely 89.8 gm., gives $k = 1.05$. Without great error we may take the average

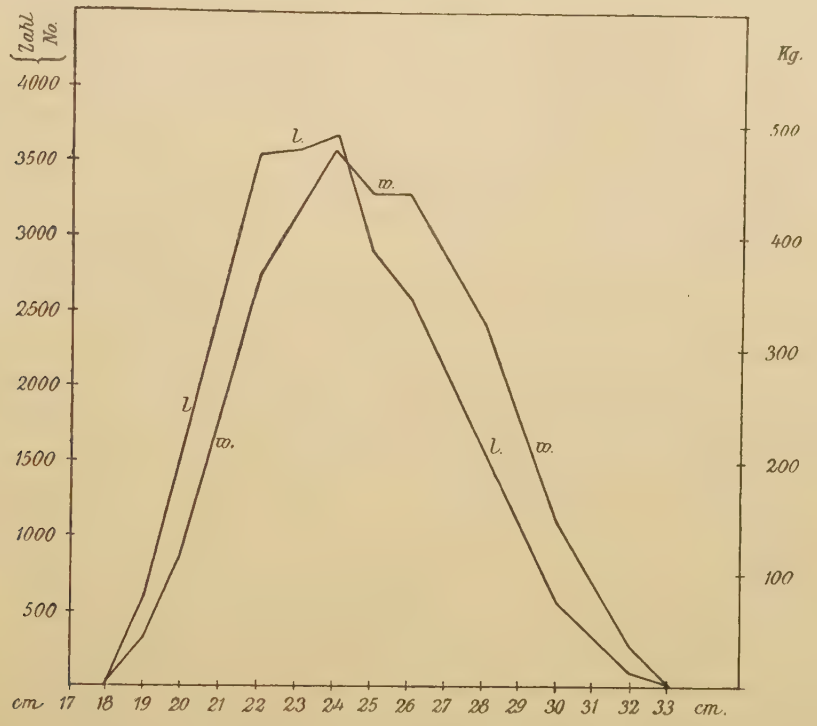


Fig. 14. Analysis by length and weight of a market-sample of "small", landed at Grimsby from area B_3, March 1906. 26,778 plaice with a total weight of 3779 kg. l curve of length, w curve of weight. Number and weight of the groups at each length directly determined. — Absolute numbers (69).

size of k as 0.85 for March and April, 0.90 for May and June, 0.95 for July and August, 1.00 to 1.05 for September to December, 1.00 to 0.85 for January and February (68). These propotions between the length and weight of plaice, which are simple but very important for our investigations, permit us frequently to draw acceptable conclusions from the length to the weight and conversely. It is possible, above all, from the lengths of a plaice sample to calculate the weight at each cm. from the number by means of k and thus from the curve of lengths to construct also the curve of weights without any weighing whatsoever.

Figs. 14 and 15 show together the curve of lengths (l) and curve of weights (w) of two samples of plaice, derived from English and Danish measurements; in the one case (fig. 14) the weight at each cm. of length was actually determined, in the other (fig. 15) it has been calculated from the length by means of $k = 1$. Above each cm. on the abscissa the ordinate represents the number of all plaice of this length and the total weight of these plaice in kg.

The curves represented in figs. 2 to 15, give a fairly good idea of the different kinds of measurement-curves derived from the analysis of plaice samples. All have this in common, as already mentioned, that the curve rises from a minimum to one or several maxima and from there descends again to a minimum. Apart from this one

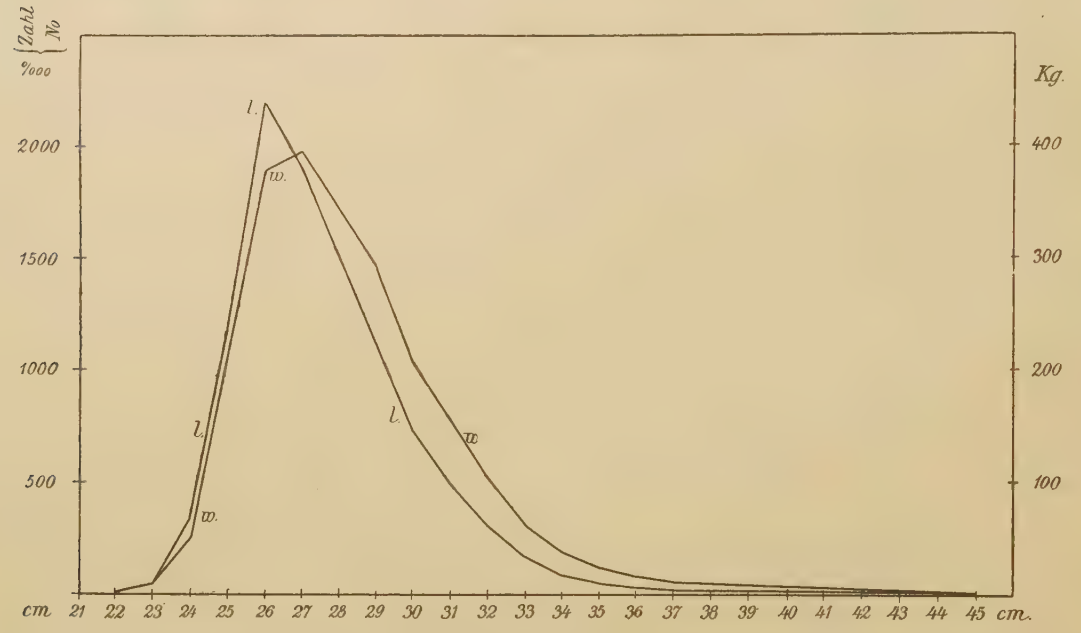


Fig. 15. Analysis by length and weight of 23,902 plaice landed at the port of Esbjerg from the North Sea in the years 1904—06 (after JOHANSEN). The length-curve (l) is constructed for the relative number of 1000 specimens (‰); the weight-curve (w) gives the weight, calculated from k = 1, of 1000 plaice at each cm. Absolute numbers (70).

great resemblance, however, very considerable differences exist between the various forms of curves.

Some of the unimodal curves, e. g. the curves of the class "small" of Grimsby (fig. 2) and of the plaice of 25 cm. according to age (fig. 12), show an unmistakable and strong tendency to assume the *symmetrical form*, the ascending and descending arms of the curve — apart from small irregularities — being a reflexion of one another. This symmetrical form of the curve suggests, that we are dealing with *curves of probability* formed according to GAUSS' law of error in measurements. This well-known law means, that the same value is never exactly obtained by repeated measurement of one

and the same dimension but very different values, which are grouped according to the law of chance about an average and probable value. A symmetrical grouping means, that equal positive and negative deviations from the average value are equally frequent and all the more frequent, the smaller they are. The magnitude of the fluctuation in the values measured is determined by the degree of accuracy in measuring. In a similar manner, the sorter on the market when sorting out the class "small", for example, may have a definite, fixed size about 25 cm. in mind and select the smaller and larger plaice round about this size according to chance. Or the plaice of 25 cm. have on an average a definite, average age, e. g. of 3 years, but vary in detail about this age, as the result of different rate of growth, according to chance and in such a way, that just as many plaice are older and younger than 3 years, with the result that equal positive and negative deviations are equally common. Here, instead of measurement we have the *natural variability* of objects originally of the same kind and in place of the accuracy of measurement the amount of this variability.

Mathematical treatment of these seemingly symmetrical curves, e. g. those represented in figs. 2 and 12, soon shows, however, that in reality they only agree very imperfectly with the simple (symmetrical), GAUSS' curve of error and indeed cannot agree with it. In the curve "Grimsby small" there is a set lower limit, under which the sorter cannot pick out any plaice, as they do not occur, whilst upwards naturally there is no such limit; the unavoidable result is, that the arm of the curve descending from the average or maximum value spreads out further than the ascending, that is, the curve is *asymmetrical* and limited towards its lower end; positive deviations are more probable than negative deviations of the same size. If, further, the single specimens are grouped together about a principal value according to chance, we obtain an asymmetrical curve of probability or, in the case of the natural variability of similar objects, an asymmetrical curve of variation. Of these asymmetrical curves of chance a whole series of different types have been distinguished. It is only in very few cases, however, practically never, that we can succeed in referring the curves obtained in our work from the analysis of plaice samples in a satisfactory manner to these probability curves of FECHNER and PEARSON (71). The mathematical formulæ for these curves presupposes, namely, that the material of the curve is perfectly homogeneous; that is, the specimens concerned must be quite of the same kind, a product of the same biological, physical and temporal conditions and must vary only according to pure chance. *With our plaice samples, however, this is almost never the case.* The material of the age-curve of fig. 12 is homogeneous in so far, that all the plaice are 25 cm. long. But the material is a mixture of males and females, which live and grow up under essentially different, biological conditions; for example, the males of the same size are on an average older than the females. The material of the curve fig. 12 is thus in no way homogeneous; it consists rather of two groups of individuals essentially different from one another, which vary, therefore, not only according to chance but also according to the sex, and have different average values. These series or curves, which are composed not of homogeneous but of heterogeneous material, are called *complex*. They may seem at first sight extremely similar to the homogeneous curves, but a relatively simple process of calculation readily shows in most cases, that their true nature is complex. The presence of subsidiary maxima in addition to the highest maximum, or of recognisable

undulations, especially cusps, in the course of the curve, which do not disappear however much we increase the number of individuals, is for example distinct evidence of a complex nature. The previous pages have shown that most of our curves from catches and the market have this appearance.

Almost all our curves of plaice samples, of every kind, are complex curves and, naturally, cannot be otherwise. The curve of 77,135 plaice (fig. 9) landed and measured in German ports from area C_2 in the year 1909 consists, for example, not only of males and females, but also of separate groups of very different age, we may say 2 to 25 and more years; the material is thus in no way homogeneous.

I agree with EUCKEN (72), that it is quite meaningless and useless to try and find an empirical, mathematical formula for these complex curves. On the other hand, it may be of importance in some cases and also possible, in part, to split up these complex curves into their components (part-curves).

Though it may not be possible to reduce the series or curves obtained from the investigation of plaice samples to empirical, mathematical formulæ — like the curves of error — and thus to ascertain the law of the curve and calculate the certainty contained in the value of all its separate elements, we may yet determine by calculation *the amount of certainty in a few, characteristic magnitudes of such a series,* namely, certain separate and principal values. This will be done with good results on discussing the question of the representative value of the samples.

The characteristic magnitudes or elements of the curve which are of special importance for the purpose of our present investigations are the following.

1. The *separate values* or items (a) of a series or curve, especially the number of plaice of a given length, thus of each single length, contained in a sample. In fact, it is of the greatest importance for all further conclusions to know, how many plaice of each length, e. g. from 18 to 70 cm., are contained in a sample and in what proportion these separate values stand to one another and to the total number of all plaice.

2. The *arithmetic mean* (average), A, of a series, that is, the sum of all the single values a divided by the total number of plaice S $\left(\frac{\Sigma\, a}{S}\right)$. With reference to this value (1) the sum of the positive deviations is equal to the sum of the negative and (2) the sum of the squares of the deviations is a minimum, that is, smaller than from any other value.

3. The *central value* (median) C (M) or the *mean of the numbers*. Its properties are the following: (1) it has just as many larger a over it as smaller a under it, i. e. the half of all a; (2) the number of the positive and negative deviations from it is a minimum i. e. smaller than from any other value. The ordinate of the median divides the whole area of the curve into two sections (halves) equal in area.

If we count from the median one quarter of the way up and down the series (i. e. one-fourth of the total number of plaice), we obtain the two so-called *quartiles* (Qu), that is, those values between which one-half of all the plaice lie, or expressed graphically, between the ordinates of which one-half of the total area of the curve is enclosed. Similarly, counting from the median we obtain the two so-called *deciles* (Dc) between which 80 % of the total number of the series lie, and the two *vigintiles* (Vg) between which 90 % of the total number of the series lie. Lastly, the two values between which 100 % of the total number lie are the two *extremes* (upper and lower) of the series,

the distance of which from one another gives at the same time the range of variation of the curve.

These values of a curve (C, Qu, Dc, Vg), which are obtained by simple arithmetic, have a very great, practical importance for our investigations.

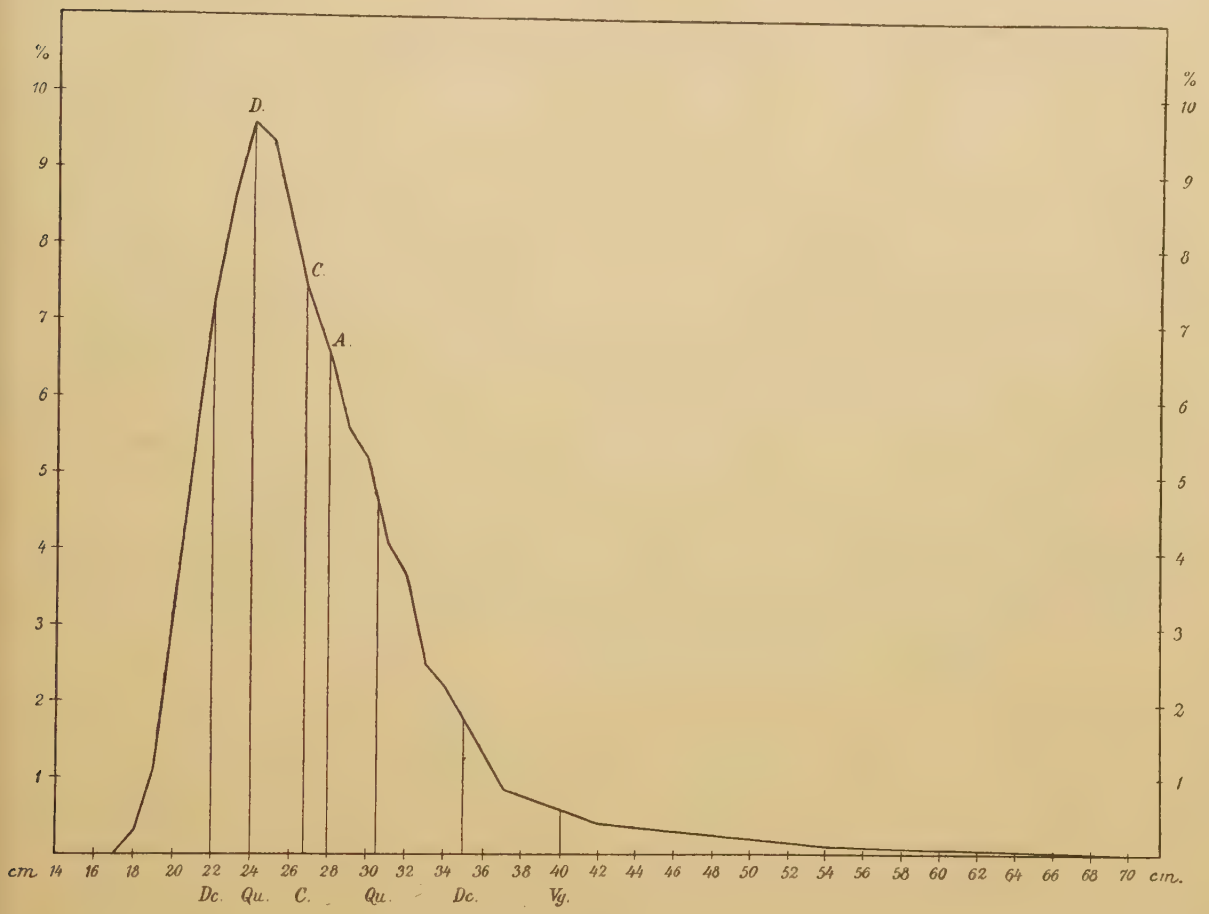


Fig. 16 Analysis by lengths of all the market-samples which have been measured in the English ports of Grimsby, Lowestoft, Ramsgate and Boston, during the period from October 1905 to the end of September 1908; altogether 4,925,698 plaice. Percentage curve. Appendix Table XVII.
D Mode or greatest density, C Median, A Arithmetic average. Qu, Dc, Vg, quartiles, deciles and vigintiles.

4. The *most frequent or highest value* (mode), D (Md), of a series is the particular value of a which occurs most frequently or which represents the greatest density of a. It is at once apparent from a curve as the highest point (maximum). In unimodal curves D represents the point where the ascending arm changes over into the descending arm.

Theoretically, D is the least important of the three main values in the case of our, mostly complex curves. As its exact value is only determined by its neighbouring, single values and not, as in the case of A and C, by all the single values of the whole

series, its precise position is dependent on many chance circumstances. Practically, on the other hand, the point D has a considerable importance for our plaice investigations. In all curves constructed from a large series of market-samples from the most different months and areas, for example, it is at approximately the same position, between 24 and 25 cm., and indicates here the point at which the so-called *frequency curve* (right arm of the whole curve) changes over into the so-called *selection curve* (the left arm). The former gives us a more or less true picture of the natural distribution (mutual proportions) of the different sizes of plaice from the value D upwards, whilst the latter is the product of the selection, which the plaice actually occurring in the sea are subjected to, from the local conditions of distribution, the size of mesh in the net and from the fisherman himself.

In the case of quite symmetrical curves of error the three main values A, C and D fall at one and the same place, the maximum of the curve. In all other curves, e. g. all those we have to deal with, they are separate from one another and in general the more so, the greater the asymmetry of the curve. Their position in relation to one another is nevertheless always, that C lies betwen D and A, though always nearer to A than B, and they are arranged in the order D-C-A from left to right in most of the curves we are concerned with.

Determination of the representative value of a plaice sample from the calculation of the probable error of characteristic magnitudes (73).

1. *The probable error in the number of plaice of a certain length in a sample.* As example we may take the series of measurements represented graphically in fig. 8, which is derived from a sample caught by the "Poseidon" on area B_4 in September 1907, containing 15,843 plaice of 10 to 53 cm. in length.

This series has the following composition:

Length in cm.	10	11	12	13	14	15	16	17	18	19	20	21
Numbers.....	1	10	34	186	680	1580	2059	2196	1721	1461	1222	1015

Length in cm.	22	23	24	25	26	27	28	29	30	31	32	33	34
Numbers.....	816	673	554	425	295	269	171	143	105	81	40	33	24

Length in cm.	35	36	37	38	39	40	45	50	51	53
Numbers.....	17	12	6	5	3	1	1	2	1	1

At the length 17 cm. there are 2196 plaice or 13.86 % of the total number. The question arises now, whether and to what extent this sample can be regarded as representative of the stock of plaice in the area B_4 in September, so far as this is caught by the ordinary trawl, considering here both the whole composition and also the number which falls at a length of 17 cm. In other words: how far can we expect, that further samples from the same time and place will have the same composition and absolutely the same or relatively the same numbers at each length? If variations occur, are these to be regarded as due to mere chance? Presupposing that the outer and inner conditions of the stock and the catch show no essential, but merely accidental

differences, the probable error r_n for the number of specimens at a certain, definite length is obtained from the formula

$$r_n = \pm 0.6745 \sqrt{\frac{n \,.\, S-n}{S}}$$

where S is the total number in the sample (15,843) and n the number (2196) at a certain, definite length (17 cm.). In this case r_n is equal to 29.33, which means that the empirical number 2196 obtained at the length of 17 cm. contains the probable error of 29.33, or

$$n_{17} = 2196 \pm 29.33$$

As it lies in the definition of the so-called probable error, that its range extends to one-half of all possible cases, this means, that we may expect, when repeated samples of the same dimensions are taken in large number, that the number at a length of 17 cm. will lie between $2196 + 29.33 = 2225$ and $2196 - 29.33 = 2167$ in the one half of the cases, but in the other half of all cases will be smaller than 2167 or greater than 2225.

In the same manner we may calculate the probable error of the number at any cm. in the series, e. g. for 25 cm. we have

$$n_{25} = 425 \pm 13.67$$

It is not practical in many cases to calculate the absolute value of the probable error, but instead its relative value, best of all how many per cent it represents of the varying dimension. In this way we have

$$n_{17} = 2196 \pm 1.33\,\% \text{ and } n_{25} = 425 \pm 3.22\,\%$$

The probable error is a measure of the representative value of a series; the smaller the probable errors, especially the proportional probable errors of the separate values (numbers at the different sizes) of a series, the greater is their representative value; that is, we can expect with all the more certainty, that all further samples taken under similar circumstances and the whole stock itself will have the same composition as the first sample. The series of measurements given in Appendix Table XVII and represented graphically in fig. 16 embraces all the plaice measured in four English ports in the years October 1905/1908 from all areas of the North Sea. In this series of nearly 5 million plaice the number at a length of 25 cm. is

$$n_{25} = 461{,}665 \pm 436 \text{ or } \pm 0.094\,\%$$

A percentual probable error of scarcely $^1/_{10}$th per cent is so small, that we may readily accept this series of measurements as representative, so far as the relative number of plaice at 25 cm. is concerned, for all the landings in the four ports during the three years of observation; provided that the different lengths of plaice in the series are mixed in the same way as in the landings themselves.

Just as for the number at each length, we may also calculate the probable error

for any desired group or sum of single values, e. g. for the number of all plaice of a sample from 18 to 25 cm.; or for any part or fraction of the total number of all plaice in a sample, e. g. for $^1/_{10}$th, $^1/_4$th, $^1/_2$, $^3/_4$ths and so on.

The formula $r_n = 0.6745 \sqrt{\frac{n \,.\, S-n}{S}}$ gives the purely *theoretical* calculation of the probable error of n; it is assumed here that the investigations themselves have been carried out correctly and that the plaice taken from a catch and measured have been properly mixed together. It is possible, however, to calculate the probable error in a number (n) of plaice of the same size (25 cm.) in a sample in an *empirical* manner. If we have a well-mixed sample, we may divide it before measuring into a large number of portions containing the same number of specimens, then determine the average of the numbers of 25 cm. plaice in these portions and calculate the probable error of this average by means of the sum of the squares of the deviations. For the probable error calculated *empirically* in this way we have the formula

$$r_n = \pm 0.6745 \sqrt{\frac{r\,(\Sigma \triangle^2)}{r-1}}$$

where r is the number of portions and $\Sigma \triangle^2$ the sum of the squares of the deviations from the average of the separate values, or numbers at 25 cm. in the different portions.

Inaccuracies in the measurement and mixing of the samples are contained in this empirical error for n, which are regarded *a priori* as not present in the theoretical calculation; it is to be expected, consequently, that the empirical error will in general be somewhat greater than the theoretical. The agreement of both errors would mean accurate measurement and correct mixing.

2. *The probable error of the median* (and of the similar values quartiles, deciles etc.) can very readily be obtained theoretically in conjunction with the calculation of the single values. We have the following formulae:

for the median: $$C \pm \frac{0.6745}{2} \cdot \frac{\sqrt{S}}{\mathcal{F}} = \frac{0.3372\,\sqrt{S}}{\mathcal{F}}$$

for the quartiles: $$Qu \pm \frac{0.6745}{4} \cdot \frac{\sqrt{3\,S}}{\mathcal{F}} = \frac{0.2933\,\sqrt{S}}{\mathcal{F}}$$

for the deciles: $$Dc \pm \frac{0.6745}{10} \cdot \frac{\sqrt{9\,S}}{\mathcal{F}} = \frac{0.2028\,\sqrt{S}}{\mathcal{F}}$$

for the vigintiles: $$Vg \pm \frac{0.6745}{20} \cdot \frac{\sqrt{19\,S}}{\mathcal{F}} = \frac{0.1469\,\sqrt{S}}{\mathcal{F}}$$

where S is the total number of specimens in the series and $\mathcal{F}$ the number of specimens in the interval, within which the values concerned lie.

In the case of the sample of 15,843 plaice (fig. 8 and p. 40), the probable error

of the median becomes $C = 18.68 \pm 0.025$; for the large, English market-sample of 4,925,698 plaice we have $C = 26.7 \pm 0.0018$.

3. *The probable error of the arithmetic average* A can only be calculated theoretically, when the sample is a pure curve of error. As this is practically never the case, we can only calculate it empirically by dividing the sample into equally large portions. We may expect, in general, that the probable error of A is somewhat greater than that of C.

The methods given above from EUCKEN, to determine the probable error of certain characteristic magnitudes in a series, only apply in the case of an *infinitely large catch* or at least a maximum catch, for example, with reference to the whole stock of fish that can be caught on a certain fishing-ground or in the whole North Sea. If it were possible to analyse this infinitely large catch or the whole stock, the probable error would be equal to O, that is, we would obtain the true value for the magnitude concerned free from all error, for example, the median of the total stock.

In the case of the majority of our investigations on plaice samples, and these the most important, it is not, however, a matter of the relation of the samples to an infinitely large catch, but to a catch, certainly larger, yet limited. This applies especially to the investigations on the composition of the plaice landings from definite areas of the North Sea or from the whole North Sea in separate months or in the whole year. Of these landings only a very small part can as a rule be actually analysed, by far the greater part remains uninvestigated. For example, only a definite part by weight N is measured out of the whole plaice catch of a steam-trawler, the other and greater part M by weight is not measured. The question arises now, how far the composition of the part measured is representative of the whole catch. Or, only a certain fraction of the weight of the total landings during a certain period (month, year) is measured and it is desired to find the representative value of this fraction for the whole quantity. If the number of specimens at a certain, definite length is n in the portion measured, n_1 in the whole catch, and if we assume, what is *a priori* probable, that $\frac{n_1}{n} = \frac{M+N}{N}$ thus $n_1 = n \cdot \frac{M+N}{N}$ then, according to EUCKEN, the probable error

(1) of n is $r_n = 0.6745 \sqrt{\frac{n\,(S-n)}{S}}$

(2) and of n_1; $r_{n_1} = 0.6745 \sqrt{\frac{n\,(S-n)}{S}} \cdot \frac{M}{N}$

from which we obtain r_{n_1} in percentage of n_1, thus

(3) $r_{n_1}\,(\%) = 67.45 \sqrt{\frac{(S-n)}{n\,.\,S}} \times \frac{M+N}{M}$

It is evident, that when $N = M + N$ or $M = o$, that is, when the total catch and not merely a portion (N) is analysed, the probable error becomes o or will approach to o, the smaller the unmeasured portion of the catch is. On the other hand, the

percentual error of n_1 calculated from formula (3) approaches greatly to that for the n of the measured portion N of the catch, the smaller the latter is relative to the unmeasured portion M.

As example we may take the 4,925,698 plaice with a weight of 255,000 kg. in round numbers, which were measured during the period October 1905/08 in four English ports (curve fig. 16 and Appendix Table XVII). According to MASTERMAN these plaice amount by weight to 1.26 % of all the plaice landings by first-class vessels from the North Sea in the ports of the east coast of England during the same period. From this, the proportion of the unmeasured to the measured part of the total catch is as 98.74 : 1.26. For the length of 25 cm. we have

for the part measured N; $n = 461{,}665 \pm 436$ or ± 0.094 %
for the whole catch $M + N$; $n_1 = 36{,}640{,}042 \pm 34{,}167$ or ± 0.093 %

As was to be expected from the smallness of N, the percentual errors of N and M + N differ but little. Their value of 0.09 is sufficiently small to make the measured sample representative for the total landings, though, naturally, it could be still further reduced by the measurement of still more plaice. If four times as many plaice had been measured, thus $4 \times 1.26 =$ approximately 5 per cent by weight of the total landings, the percentual, probable error would be reduced from 0.093 % to 0.090 %; by investigation of 10 % by weight to 0.085 %; of 50 % to 0.047 %. The last value means, that an increase in the number of plaice measured by forty times only produces a decrease of one half in the probable error. It is evident from this, that the gain arising from an increase in the number of measurements is in no proportion to the enormous increase in the work of measurement.

As already explained, however (p. 36 *et seq.*), such an exact determination of the probable error of any item or member of the series (or median etc.) as that shown above, has but very little value for our purposes, for this determination is a purely theoretical one, that is, under the supposition, that all plaice samples are in a naturally mixed condition and that all measurements and weighings have been made free of error. This is almost never the case and new sources of error are thus present in the calculation of the single and mean values, which have far more influence on the latter than the purely chance errors. For example, the insufficiently exact determination of the weights of the landings in the fishing-ports is a very important source of error, making (as EUCKEN (74) shows) the empirical error much greater than that calculated theoretically. The probable error is still more increased by the influence of errors in the right mixing of the market samples investigated, or, as expressed above, by errors in the selection of the samples, since, for example, from catches originally of the same composition relatively too many small plaice may be taken the one time, too many large at another.

As example of this we may make a comparison of the English market-measurements in the years 1906, 1907 and 1908, in regard to the median and its theoretical probable error. (Cf. Tables XIV—XVI of the Appendix).

Number of plaice measured 1906 — 1,552,572 ; $C = 25.94 \pm 0.0029$
— - — — 1907 — 1,775,658 ; $C = 26.91 \pm 0.0031$
— - — — 1908 — 1,597,468 : $C = 27.29 \pm 0.0036$

The probable errors for the three years are so small, that some differences must be considered to have crept into the landings of the three years, which are not of a purely

chance character. From the difference in the size of the medians and in the composition of the three yearly samples it follows, *inter alia*, that in the year 1906 relatively many more small plaice have been contained in the sample than in the years 1907 and 1908, and in the case of the last two again somewhat more in the year 1907 than in 1908. If, now, we build upon the theoretical, probable error and regard these three yearly samples as in high degree representative for the total landings in each of the three years, the conclusion would be, that a very remarkable difference had occurred in the composition of the total landings of each year. We might even draw the further conclusion, that the year 1906 had been a bad plaice year, in so far as the average size of the plaice was distinctly smaller then than in the two other years. This conclusion — though correct theoretically — would not be permissible empirically. It can be definitely shown, that in the first year of the English market-measurements — October 1905/1906 — the selection of the market-samples had not yet been carried out on a systematic and uniform method and especially, that the intention in the beginning was to determine the amount of the destruction of small plaice, with the consequence that, by comparison with the weight of the different market-classes in the total landings, distinctly too many "small" plaice were measured. The mean values found by measurement in the year 1906 are thus certainly lower than the actual averages in the total landings of the year and probably so very much lower, that the whole series of measurements must be regarded as not sufficiently representative. It is even possible and probable, that the difference in the median and arithmetic average for 1906 by comparison with the two other years, from 1 to 2 cm., must be placed entirely to the count of this insufficient selection of the market-samples. In the years 1907 and 1908 a much more uniform and rational method was used in the selection of the samples and in this we have probably the explanation of the fairly good agreement between the average values of these two years. The differences between these two years, which still remain and are not altogether due to chance, might well arise for the most part from a certain, though smaller, imperfection in the choice of samples, which by producing a possible discrepancy of as much as $\pm$ 0.2 between the empirical and theoretical, probable errors, would be sufficient to make the existence of a real difference in the values for the two years improbable.

To attain to certainty in our conclusions, therefore, a good selection of the samples is of greater importance than an increase in the number of the separate measurements beyond a certain limit. The difficulties in the way of such a good selection are, however, in my opinion, still so great at the present time, even with the greatest of care and circumspection, that we must meanwhile give up hope of very great, numerical certainty in our results. So far as the composition of the plaice landings is concerned, we must be satisfied for example with a probable error of $\pm$ 0.2 cm. in the average values — practically also we may be satisfied with this — that is, a reliability within the range of 1 to 2 centimetres.

Other graphic methods of representing series of measurements. Summation or integral curve. Logarithmic curve. The most usual method of graphically representing the series of measurements from a catch or market-sample, where the absolute or percentual numbers at each size (or weight) are entered as ordinates in a coordinate system, as in the examples given above, permits all details to appear clearly in the course of the

curve, and especially the irregularities — whether these are casua arising from the small number of measurements, or not casual and lying in the real composition of the catches. This method of representation has a great advantage over others, if the sample can be regarded *in the details of its composition* as representative for large catches. As this is

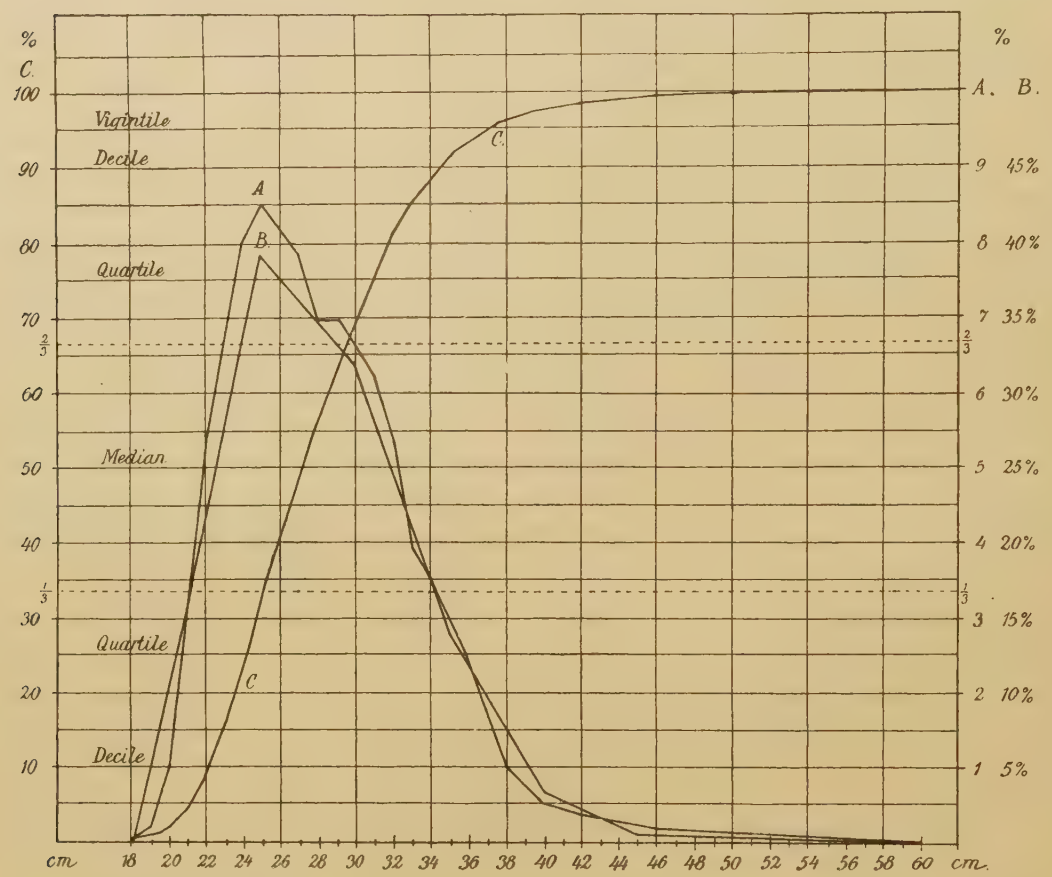


Fig. 17. Analysis by lengths of 34,209 plaice from area B_2, measured in English ports in June of the three years 1906—1908. A. ordinary curve with the numbers for each single centimetre; B. smoothed curve with the numbers for each 5 centimetres; C. summation or integral curve. Percentage curves (75).

by no means always the case, it is frequently advisable to smooth out the irregularities in the details of the curve, in order to obtain a better picture of its general course. This is best done by taking, not the single values or items of a series of measurements, but the sum of a series of adjoining single values. This, again, may be done in two different ways. (1) We may divide the series into a number of successive sections embracing an equal number of items or values, e. g. 5, and then calculate for each of these the sum of the single values. This process gives a *smoothed* curve similar to the

ordinary curve. (2) At each centimetre we may take, not the actual number found there, but the total number of fish from the lowest item up to and including the length in question. The first item in the new series will thus contain the number of specimens at the lowest centimetre, the last item the total sum of all the specimens. This process results in the *summation or integral curve* which has an essentially different appearance from the other curve.

Fig. 17 gives the three different methods (with different scale for the ordinates) of graphically representing one and the same market-sample (from area B_2, June $^{1906}/_{08}$). A is the ordinary, B the smoothed (from 5 to 5 cm.) and C the *summation curve*. All 3 curves are drawn here as percentage curves, which is of advantage especially in the case of the summation curve.

It will be seen, how the course of the curve obtained by the ordinary graphic method (A) has a conspicuous irregularity between 27 and 30 cm. This, probably casual irregularity disappears entirely in the smoothed curve (B). Apart from this, the course of the curves in A and B is in the main the same. The summation curve C appears still more smoothed, yet we can also clearly recognize here the general course of the curves A and B. If we compare, for example, the two parts of the smoothed curve B from 25 cm. (the value of greatest density) to 30 cm. on the one side and from 30 to 35 cm. on the other, we remark at once the much steeper slope of the curve on the latter side by comparison with the gentler slope on the former. In the summation curve this difference is represented by the fact, that the curve is almost straight between 25 and 30 cm., but shows a sharp bend between 30 and 35 cm.

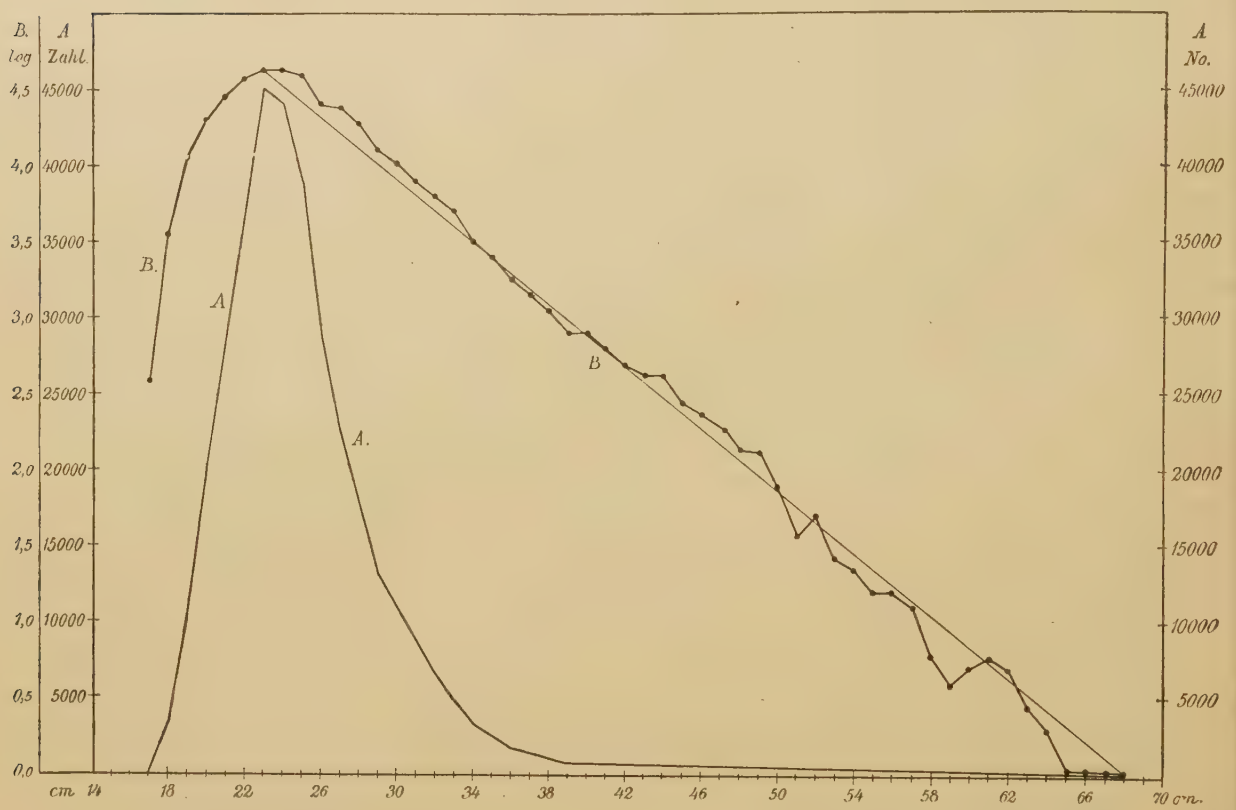
For our practical investigations the *summation curve* is the most important and in many cases quite indispensable form or method of representing series of measurements, the latter, for example, when we wish to know, how many plaice (by number or weight) fall below a definite length by comparison with the total quantity (e. g. a definite size-limit). In the summation curve equal divisions of the ordinate correspond to equal quantities of plaice (number or weight) in the corresponding division of the abscissa (lengths). If we divide the ordinate into a number of equal parts (in fig. 17 into 20, each equal to 5 % of the total quantity and also into 3, each equal to 33.33 %) and draw parallel lines to the abscissa through the points of division, the points of section on the summation curve show those divisions of the abscissa on each of which 5 % or $^1/_3$rd of the total quantity fall. The ordinate is divided as a rule, and with advantage for our purposes, not into equal sections, but from O onwards into the following: 10 %, 25 %, 50 %, 75 %, 90 % and 95 %. Thus, the lines parallel to the abscissa through the points of division cut the summation curve in the points already referred to, namely deciles, quartiles, median and vigintiles. The most important point of the summation curve is thus the *median,* which divides the total quantity into two equal parts; then the two quartiles (upper and lower), between which lies 50 % of the total quantity. The divisions of the series (lengths) lying between these are called the *predominant range of size* of a catch. In the present example (fig. 17) this range extends from 24 to 31 cm.

In the subsequent part of the Report we shall very frequently use the summation curve in this modification.

Logarithmic curves. In many cases it is of great importance to know, in what proportion the number of specimens at each item of a series (size) increases from item to item up to the maximum, or decreases from there down to 0. For example, if we

have a series of 1000 plaice represented in fig. 17, with 66.5 at 30 cm., 62.4 at 31 cm., 53.6 at 32 cm., 38.5 at 33 cm., then the number of plaice at 31 cm. amounts to 94 % of the number at 30 cm.; the number at 32 cm. 86 % of that at 31 cm. and the number at 33 cm. 72 % of that at 32 cm. To display such a percentual increase and

Fig. 18. Two analyses by lengths of plaice samples,



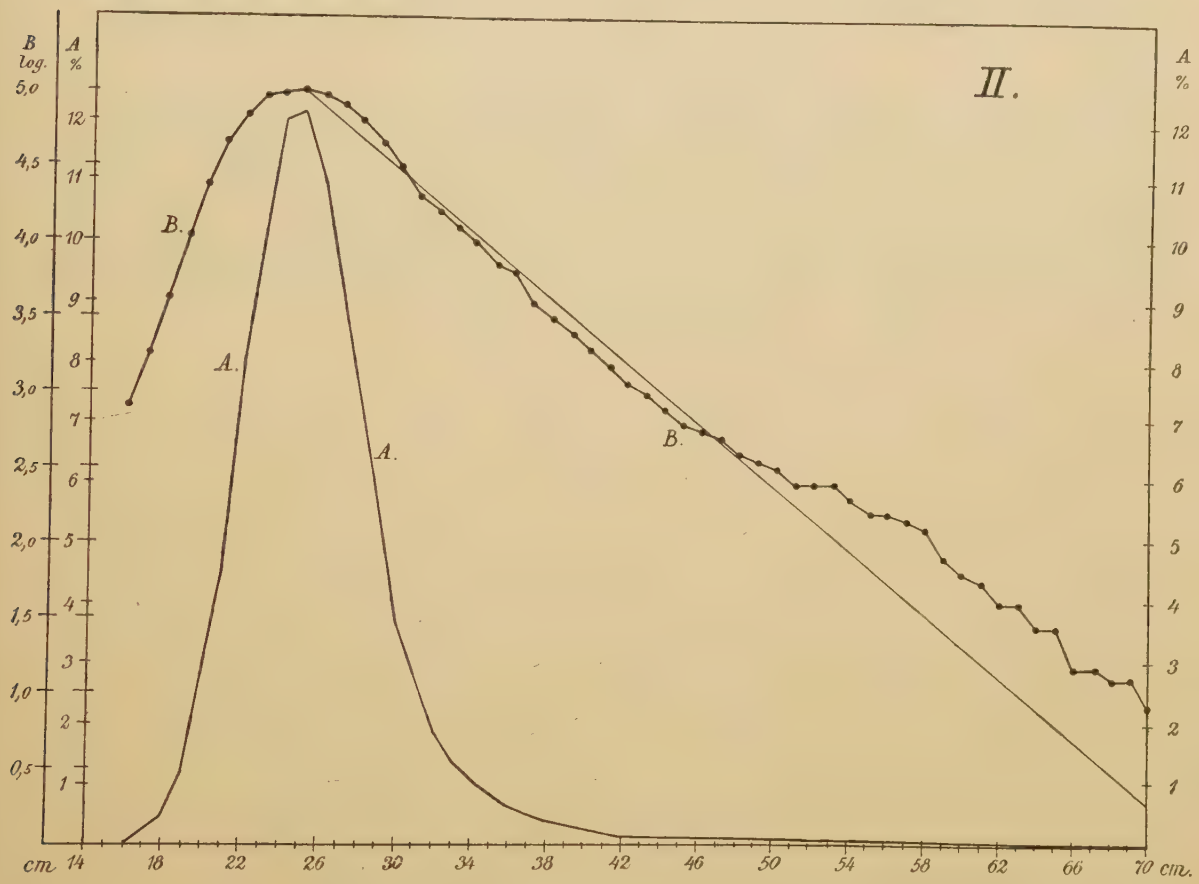
I. 362,406 plaice of all sizes, landed in Lowestoft in the year 1906 and measured as the market-class "other". — Absolute numbers. — From EDSER (76).

decrease in the proportions as clearly as possible, it is best to represent the series of measurements as a logarithmic curve, taking for the single items not the absolute or percentage numbers, but their *logarithms*. As an equal, percentage increase or decrease of a magnitude is represented by an equal, absolute increase or decrease of its logarithm, the degree of the percentual increase or decrease of the members of a series of measurements is seen directly from the logarithmic curve.

In the two figures, I and II, of fig. 18 two series of plaice measurements are represented, each in the ordinary method (A) and also in the logarithmic (B). In the logarithmic curve only the descending arm of the curve is of interest to us. The ascending

arm is a so-called selection curve and its separate items or values are completely under the influence of the selection by the net and on the market. The descending arm, on the other hand, when the series consists of a natural mixing of catches from different areas, as is supposed here, may be regarded as the *distribution-curve*, that is, its num-

on the ordinary (A) and logarithmic (B) methods.



II. 850,550 plaice of all sizes from the areas A_3, B_3, B_4, C_2, landed and measured in German ports in the year 1909. The sizes in this curve go as far as 73 cm. and the curve has to be extended to this length. — Percentage curves (77).

In both figures a straight line has been drawn from the highest value of the logarithms (apex of the curve) down to the lowest value of the descending arm of the curve (upper end of the series).

bers give a more or less good picture of the actual, natural proportions of the different sizes in the stock of plaice.

It appears now, that this distribution-curve (the descending arm) in its logarithmic form shows the unmistakable tendency to course in a straight line over wide distances. For example, in curve I from 28 to 33 cm. and again from 36 to 39 cm., in curve II very clearly from 38 to 45 cm. A straight line within the interval of several centimetres

means here, that the percentual decrease in the numbers for the successive sizes within this interval is always the same. If we draw a straight line from the maximum of the logarithmic curve down to the O value on its descending arm (in I from 23 to 68 cm., II from 25 to 73 cm.), we see that all the logarithmic values up to about 50 cm. are grouped round about this straight line in both curves. We might from this conclude, that the whole descending arm of such a logarithmic distribution-curve may be in general a straight line. Such a curve would have a simple logarithmic equation of the form

$$\log Z = A - b \cdot l$$

where Z is the number of specimens at the length l and A and b are empirical constants. In words this means, that the percentual decrease in the number of plaice is proportional to their increase in length and always the same for each increase of length from cm. to cm. If this theory were correct — I do not believe it —, we should have a very simple formula to represent the *death-curve* of the plaice. It would be possible to calculate, for example, the probability or chances of a plaice of 25 cm. living until it had a length of 60 cm. or any other length.

II.

AMOUNT AND COMPOSITION OF THE PLAICE LANDINGS AND PLAICE STOCK IN THE NORTH SEA.

THE material, which has been collected and published as the result of the investigations of the different countries, on the amount and composition of the plaice stock in the North Sea and on the amount and composition of the quantities of plaice taken annually by the fishery from the sea, is very large but also very unequal. The material has been obtained partly from the hauls of the scientific research-steamers, partly from the fishery statistics of the fishing ports, especially the market-measurements. As already explained in detail in the preceding section, these two sources of information, the analysis of the scientific catch-samples on the one hand and the analysis of the market-samples on the other, have in principle an equal importance for the solution of the questions concerned; the scientific hauls, because they are indispensable and conclusive for the determination of the composition of the plaice stock in the sea as well as for the degree of destruction of undersized plaice by the fishery; the market-samples, because they give us direct information regarding the amount and composition of the landings.

The analysis of the market-samples has been carried out on a very much larger scale than that of the scientific hauls. Further, from a certain length of the plaice onwards, e. g. 25 cm., above which, we may believe, no selection occurs either by the net or by the fisherman, they may also be taken *as samples of the plaice stock* and not only of the landings. For these reasons the *plaice landings* (market-samples, market-measurements) will first of all be dealt with here. The question will then be discussed, whether and in how far the investigation of the scientific hauls is able to supplement and control the results of the market measurements and afford us a reliable picture of the composition of the actual plaice stock in the North Sea.

1. The plaice landings and their composition in the different countries.

The plaice landings in the countries bordering on the North Sea are very different from one another, in quantity, origin (fishing-grounds) and consequently also composition. *England* receives plaice from practically all parts of the North Sea, the largest absolute and relative quantities, however, from the southern and central parts, south of 56° N. L. and from 20 m. outwards, and here also the western areas are relatively more fished than the eastern. In the shallow, coastal areas A_2, A_3 and A_4, as also in B_5, the Skager Rak and northern parts of the North Sea, its plaice fishery is relatively inconsiderable. *Scotland* takes the main quantity of its plaice from the northern North Sea. The plaice landings in *Germany* come for by far the most part from the southern North Sea, especially from the areas A_3, B_4, C_2 and a certain, smaller part of the northern North Sea and the Skager Rak. The plaice fishery of *Holland* lies in the main in the areas A_2, B_3 and B_1. The *Belgian* is mostly in A_2, B_2 and B_3. *Denmark*, which receives most of its plaice from the Kattegat and Skager Rak, only fishes over a relatively small region in the true North Sea on the west coast of Jutland to about 6° E. L., embracing the areas A_3, A_4, B_4 and B_5 and a part of C_2. The different quantities landed in the various countries can be seen from the following data for the year 1908, which have been taken from the international "Bulletin Statistique" (78). According to this the following quantities of plaice were landed from the North Sea in that year:

in England . .	31,028,437 kg.	=	65.60 %
- Holland . .	7,637,751 -	=	16.10 %
- Germany .	2,615,220 -	=	5.50 %
- Denmark .	3,050,619 -	=	6.50 %
- Scotland . .	1,932,686 -	=	4.10 %
- Belgium . .	1,055,449 -	=	2.20 %
	47,320,162 kg.	=	100.00 %

As over 60 per cent by weight of all the plaice taken yearly in the North Sea are landed in English ports and the English plaice fishery embraces a greater part of the North Sea than is the case with any other country, the investigation of the composition of the English plaice landings has thus the greatest importance. We may begin, therefore, with these.

1. ENGLAND.

The volume or number of the English market-measurements is very considerable. They were begun in October 1905 and concluded at the end of March 1909. During this period altogether 24,462 boxes of plaice were analysed by number, length and weight, in the three fishing-ports Grimsby, Lowestoft and Boston (from October 1905 to May 1906 the measurements were made in Ramsgate instead of Boston); the total number of fish was 5,607,487 with a weight of 1,387,271 kg. (79). As the latest measurements, from October 1908 to March 1909, have not yet been published, we have to deal here only with the measurements from October 1905 to October 1908. They embrace 4,925,000 plaice in round numbers with a weight practically of 1,220,000 kg.

This means 1.3 % by weight of all the English landings of plaice from the North Sea during the same period (87,850,000 kg. in round numbers) and about 1.6 % of all the landings in the ports where measurements were undertaken.

Whether it is sufficient to analyse about 1.5 % of all plaice landings, in order to obtain representative values for the composition of these, depends, as already shown, not only and not so much on the height of this percentage, which is here fully sufficient numerially (see pp. 52 *et seq.*), but much more on the manner in which the market-samples measured have been selected. Regarding this and regarding the English material of measurements in general, the following may be said.

The English material of measurements and its elaboration.

1. *Material* (80). The general principles followed in procuring the English material have been: firstly, the measurements were made in those ports, where absolutely and relatively the greatest quantities of plaice were landed; secondly, measuring and weighing samples of the landings has as far as possible been carried on every month of each year and from each area fished over by the vessels of the port where the plaice were landed; and these samples were selected in such a way, that they might be considered as representative as possible, in their size and composition, of the landings from which they were taken.

With regard to the first point, the principal port for the English plaice fishery is *Grimsby;* here alone about 54 per cent by weight of all the plaice caught in the North Sea by English trawlers are landed and almost exclusively by steam-trawlers. Next to Grimsby comes *Lowestoft,* the principal port for the sailing-trawlers, with about 20 % of the total landings; then *London* with about 15 %, and fourthly, *Boston* with about 3.5 %. These four ports thus receive altogether about 92 % of all the English plaice landings from the North Sea; the remaining 8 % is divided among quite a number of smaller ports, chiefly however Ramsgate, Hull and North Shields (80). Of the four principal ports mentioned *Grimsby*, *Lowestoft* and *Boston* were chosen for the measurements. London had to be left out, as the practical difficulties in the way of carrying out the work there were too great. This is, however, a disadvantage in the English measurements, because the London market is mainly served with plaice from those areas, in which many small plaice are caught and in which, therefore, the question of the destruction of undersized fish is of special importance.

With regard to the second point, *the selection of the samples,* these have almost never been taken from the catches of the fishing-vessels in their original mixture when brought to market (the single landings); this was found to be impracticable. As a general rule the samples to be measured could only be obtained second-hand, from the fish-dealer, and thus packed in the ordinary way of the port in boxes and divided into the market classes usual there (large, medium, small), rarely unsorted (others, size not distinguished). Further, owing to the enormous number of landings it was impossible to take single samples of each. This has only been done, in fact, in the case of 6 to 7 % of all the landings. Here and there also there are gaps in the series, where some areas have not been investigated in certain months in this or that port. The *size* of the samples measured (by weight) in each month and from each area should be as far as possible proportional to the total landings, and thus increase and decrease with these,

in order to be as representative as possible. This is mostly not the case; on the contrary, relatively large quantities have mostly been measured from the smaller landings and *vice versa*.

The *measuring and weighing* of the samples was carried out in the following manner. All the plaice were measured to whole centimetres according to the international arrangement, the excess over the whole centimetre being discarded. All plaice of the same length in a sample were thrown together and *weighed together*; the weights thus obtained for each centimetre group were summed up and gave the total weight of all plaice measured.

The material thus obtained has been published in a series of tables, in which all the samples of each market-class, which have been measured in one port, in one month and from one area, are taken together as one sample and the figures of number of specimens and weight at each cm. are arranged in parallel columns. These monthly series are arranged again according to areas, then according to market-class and lastly according to ports.

2. *Elaboration of the material.* In working up this material the object aimed at was to obtain as true a picture as possible of the composition of the landings, according to number and weight of plaice for each centimetre of length; and this, not only for the landings of each port separately, but also for the landings of all the ports together and even, if possible, for all the English landings from the whole North Sea. As mentioned, however, the samples measured, which form the starting-point for the calculations, are not samples of the original landings, but of these landings after being arranged and sorted according to the ordinary market-classes. The first step to be taken, therefore, was to reunite these divisions, large, medium and small etc., of the original landings into one composite whole, thus to re-mix them. This may be done in two quite different ways. *Either*, the samples of the different classes, which have been selected and measured from the landings of, for example, one port, one month and one area, may be mixed together into *one series of measurements,* which is taken as representative for the composition of the whole landing. *Or*, the composition of the samples measured of "small" plaice is taken as representative for the composition of all small plaice of the whole landing and similarly the samples measured of the other classes, and from these the composition of each single class in the whole landing is calculated. The various series thus obtained for the different parts of the landing are then mixed together to give one single series. The latter method has been used by MASTERMAN on working up the English material, the former will be used here. Both methods have their advantages and disadvantages.

MASTERMAN proceeds as follows. In the Appendices II and III of his report (Plaice Fisheries Vol. I—III) he rearranges all his original measurements (in Appendix I) into two series with relative numbers, showing, firstly, the weight and, secondly, the number of plaice at each cm. of length in a unit of weight of 50 kg. With the aid of these new tables, in which there is an enormous amount of calculating work, he is enabled to calculate the composition of the landings. Suppose, for example, we have a sample of "small" plaice measured in the port of Grimsby in July from area B_4, with x plaice of all sizes in 50 kg., y the number plaice of 25 cm. and z the weight in kg. of the plaice at this length; and suppose, further, that the weight of all the "small" plaice landed in the same

port, in the same month and from the same area amounted to 50,000 kg., then this portion "small" of the landing consists of 1000 x plaice altogether of all sizes and it contains 1000 y plaice at 25 cm. with a weight of 1000 z kg. This calculation is thus based on the supposition, that equal quantities by weight of landed and measured "small" plaice contain precisely the same number at each single centimetre and on the whole. The total number of specimens of all these small plaice in the landings is then obtained by simple division of the total weight of the landed by the average weight of the measured plaice. MASTERMAN proceeds in the same manner with the parts of the same landing distinguished as "large" and "medium", on the basis of the measured and weighed samples of these. The values obtained for each market-class are then simply added together in order to give the results for the whole landing. If the same calculation is made for each single centimetre of length, a complete series is obtained for both number and weight of the whole, monthly landing, that is, its composition has been determined.

The possible errors in this method of procedure result from the fact, that the samples measured of a market-class are taken to be representative of the whole quantity of that class in the total landing. This is never exactly the case. The result would obviously be most certain, when the samples are not too small in proportion to the landing and when the market-classes are as far as possible in the same proportions by weight both in the samples and landings. So far as the classes themselves are concerned, it is probable in most cases, that a sample of small, medium or large, measured in the same month and in the same port, would correspond to the same classes in the landings, but in the case of "size not distinguished" or "others" it will often occur, that the quantities entered in the statistics of the port will not correspond with the samples measured as such; since the conception of "others" is obviously *extremely variable* in each single port.

Further — and probably greater — errors will arise from the fact, that the weights of the plaice measured, especially however of the different market-classes landed, are not exact; lastly, from the fact, that in certain months and for a certain area there are no measurements, either of all or only of one class, which has led to the use of interpolation or some other means of assistance.

By addition of the results obtained in different ports for the landings of one month from one definite area MASTERMAN arrives at the total monthly landing from any definite area and thus again at the total landings for the whole year and for all the areas together.

It must be said, that the method used by MASTERMAN is both simple and exact. Unfortunately, it has not been carried out to the extent desirable for our purposes; this could not be done owing to the enormous amount of calculating work involved. The exact calculation of the composition of all monthly landings for each centimetre according to number and weight has therefore not been made. MASTERMAN rather restricts his attention to the calculation of some few values for each monthly landing, namely, first of all the number of specimens in each landing (estimated total number of fish landed), secondly, the percentage number of plaice in these landings which are under certain lengths (20—23—26—29 cm.) and thirdly, the percentage quantity by weight of plaice under the same lengths. *These values have been selected on practical grounds*, as giving a basis for the choice of definite size-limits.

The necessity of having perfect and complete series for the composition of the

landings from cm. to cm. is however extremely imperative, especially on general theoretical grounds. Without series of this kind it is quite impossible to obtain a thorough conception of the actual composition of the plaice landings from the different areas and from the whole North Sea. As the landings from a certain, definite length (25 cm.) onwards may also serve as samples of the actual stock of plaice in the North Sea and must be used as such, the complete series are absolutely indispensable for all our conclusions as to the stock of plaice and for the necessary comparison with the catch-samples of our research-steamers. Lastly, the measurements in other countries, e. g. Germany and Denmark, have been drawn up in such complete series and a comparison between these and the English material would be impossible.

For these grave reasons and owing to the enormons volume and great importance of the English material of measurements, which far exceed those of all other countries, I felt obliged to draw up these indispensable, mixed series from the English material once more for myself. The most exact procedure and the one leading to the most accurate values would have been to calculate the single items of the series in the manner followed by MASTERMAN. This would have meant an insuperable amount of work, however, and I have consequently chosen another method of obtaining the mixed series. This method has already been described above and consists in mixing together the samples measured of the different classes, instead of the landings. This also means a very great amount of calculation, but not nearly so great as the method followed by MASTERMAN. I have proceeded in the following way. From the English tables of measurements all the plaice measured of the different market-classes, "large", "medium", "small", "others", in the same month of the same year and from the same area (taking all ports together) have been arranged in one single series by centimetre and number. In such a series, e. g. for May 1907 and the area B_3, we have, consequently, all the plaice measured in all English ports in the month and for the area mentioned, from 17, 18, 19, 20 ... 25 ... 30 cm. and so on to the greatest length observed. Such a series is thus a sample of the landings from the area B_3 in May. Combining with this the corresponding series for the other areas in May, we obtain a sample of the total landings from the whole North Sea in May. It is possible in this manner to arrange the original measurements in the most different series; lastly, even all the measurements for one single year and for all three years together to one series, which is a sample of the total yearly landings from the whole North Sea.

The Appendix to this Report contains a number of these tables drawn up by me from the English measurements. Close inspection will show, that here and there inaccuracies and errors have crept in during the preparation of the tables. Thus, in the case of large numbers which are the sum of many measurements, smaller or larger differences may be present between the English data and my tables. These small discrepancies will perhaps be excused, when the enormous amount of calculating work is considered; I do not believe, that any essential error is present, which might lead to erroneous conclusions.

It will be seen from these tables, that I have restricted myself to the data of the numbers of plaice for each centimetre and have not dealt with the English determinations of weight. This would have more than doubled the work without any corresponding gain, since the weight of the plaice in a series of measurements can at any time be

calculated without essential error by means of the known formula already discussed above (p. 44), $w = \frac{k \cdot l^3}{100}$, if necessary. This theoretical calculation of the weight from the length even gives in general more reliable and especially more comparable results than the empirical determinations of the weight on the market. The former, namely, are dealing with fresh, ungutted plaice, the latter, however, practically never with fresh plaice and only for a small part with ungutted (entire) plaice. The majority of the market-samples consist rather partly of gutted and ungutted, partly of a mixture of both (cleaned, entire and cleaned), and the weight-material is thus very unequal.

The fact, that my tables do not include the English weight determinations, does not mean,. naturally, that these are superfluous for the subsequent discussion of the results from my own and MASTERMAN's elaboration of the material. On the contrary, the summary weights of the English market samples are indispensable for the determination of the representative value of the new samples obtained by me from mixing the trade-classes and will be used accordingly. All such data of the weights have been taken from the English Report, "Plaice Fisheries" Vol. I, Tab. XVI—XIX, Vol. II, Tab. XIV—XVI and Tab. LIV—LVI or calculated from these.

3. *Discussion of the representative value of the mixed series of measurements.* It is certain, that the method followed by MASTERMAN, which starts from the original series of measurements, samples of the various market-classes, and proceeds by their means step by step to the calculation of the composition of the mixed landings, is an exact procedure involving relatively small errors. It rests only on the condition, that the sample of "small" plaice measured, e. g. in any port in a certain month and from a certain area, is representative in its composition of the total "small" plaice landed in the same port, in the same month and from the same area. In most cases this may be accepted without question, if the sample measured is not too small.

It is quite different with the mixed series of measurements, as I have constructed them. They will only lead to an equally certain result to MASTERMAN's method, that is, they will only be sufficiently representative, when the weights of the different samples of the various market-classes united into one series stand in the same relation to one another as the weights of the market-classes composing the whole landing, which the sample is to represent; in other words, if an equal part by weight is measured of each market-class in the landings (large, medium, small, others), for example, always 1 %.

It may now be investigated, whether and in how far the English market-samples measured fulfil this essential condition for a representative value of the series constructed by me. It will be shown, that this is the case in general to a very satisfactory extent and even more than we should have expected. Certain series prove to be of little use, it is true, others only after a certain correction is introduced.

How should the market-samples have been selected in this sense and how far do they meet requirements?

The end would obviously be attained in the surest way, if it were possible to take samples from each large landing of a vessel, which had the same composition in this sense as the whole catch. If this weighs 20,000 kg., for example, and is composed of 5 per cent by weight of "large", 20 % "medium" and 75 % of "small", then the sorting of the catch into boxes of 50 kg. each means, that for 1 box of "large", 4

boxes of "medium" and 15 boxes of "small" must be investigated, in order to make the sample representative. It is at once clear, that to carry out such a consistent selection of the market-samples is impossible qualitatively and quantitatively, still more even when the endeavour it made consciously but can only be carried out practically to an imperfect degree. A great difficulty in the way is, that the procedure used in sorting the plaice on the market is essentially different in the different English ports (82), e. g. in Grimsby and Lowestoft. In Grimsby, where the largest quantity of plaice is landed by *steam-trawlers*, a fairly definite and fixed mode of sorting has been adopted, namely, into small, medium and large. The "small" include plaice of 16 to 40 cm., mostly 17 to 30 cm. with a median or central value about 25 cm. and an average weight of 150 gm. in round numbers. The "medium" are plaice of 22 to 45 cm., mostly 25 to 35 cm., with a central value of about 32 cm. and average weight of 320 gm.; the "large", lastly, vary from 25 to 70 cm. with a central value at 49 cm. and average weight of 1200 gm. in round numbers. The sorting in Boston is very similar to that in Grimsby. In Lowestoft, on the other hand, where most of the plaice are landed by *sailing-trawlers*, the manner of sorting is quite different. Here, the small plaice are sorted out first of all and the rest is taken as "large"; thus, the whole catch is only sorted into *two* groups, instead of *three* as in Grimsby. When "medium" are noted in Lowestoft, this always means smaller than the ordinary "large". The class "small" in Lowestoft includes plaice from 15 to 43 cm., mostly 20 to 30 cm. with a central value of about 24 cm. and an average weight of 130 gm. in round numbers; it is thus composed distinctly of a somewhat smaller sort than in Grimsby; the "large" lie between 20 and 70 cm. with a central value of about 32 cm. and an average weight of about 340 gm. Apart from these two classes of small and large, unsorted catches are also sold at Lowestoft, which are entered as "others" and compose about 15 % of the total landings there. The sizes of the plaice included under the unsorted "others" lie mostly within the same limits as the small and large together, but their average size, according to a calculation I have made on the basis of measurements and weighings for the period 1905/08, is in a surprising manner considerably smaller that that of the small and large together (about 160 gm. average weight compared with about 200 gm.). This leads one to conjecture, that catches containing relatively many large plaice are probably always sorted into small and large, whilst only those catches remain unsorted for the most part which contain relatively many small plaice.

In addition to this difficulty in the way of obtaining a representative selection of the market-samples, namely, the difference in the market-classes in the two most important ports, we have also, that the market-classes in one and the same port are not fixed but are more or less variable groups in regard to their composition and the average size of the plaice. This is shown, for example, by the following calculation based on the measurement material of the period 1905/08:

	Grimsby		Lowestoft	
	average weight of class		average weight of class	
	small	large	small	large
	gm.	gm.	gm.	gm.
I. Oct. 1905/06	155	810	147	338
II. Oct. 1906/07	167	1238	127	316
III. Oct. 1907/08	138	1220	125	392
I.—III.	154	1204	133	343

These differences are in part fairly considerable and mean a difference in the average length of as much as 6 cm. (Grimsby large 810 and 1238 gm.). The causes of *these differences in the different years* are unknown, but it is evident, that, when the measurements of the market-samples are mixed, they will not be without influence on the average finally obtained for the composition of the total landings. In other words, the variations from time to time in the composition of the market-classes constitute a new source of error for our investigations.

A further, very noteworthy difference in the market-classes is found on considering the areas. It appears from examination of the English market-measurements, for example, that what is called "small" under the different areas and is measured as such, is by no means always the same. It appears rather, that the average weight of the market-class "small" is in general higher, the greater the average length of all the plaice of an area. Thus, the average weight of the class "small" in the English measurements amounts to: from A_3 144 gm., from B_4 165 gm., from B_3 152 gm., from C_3 138 gm., from B_2 191 gm., from C_2 234 gm., from C_1 207 gm., from B_1 341 gm., from D_1 316 gm. These are quite enormous differences. The small from B_1 weigh more than twice as much as the small from B_4 and even somewhat more than the medium plaice from B_4 (318 gm.). We see, therefore, that when the landings come from an area with a plaice population of greater age and greater average length, the grouping into the three classes of small, medium and large is quite different and naturally of such a character, that the small and medium are almost always larger on an average, than in the case of areas with smaller and younger plaice. The average weight of medium plaice in the English measurements is: area A_3 283 gm., B_4 318 gm., B_3 313 gm., C_3 259 gm., B_2 243 gm., C_2 441 gm., C_1 369 gm., B_1 510 gm., D even 657 gm. Among the large also there are remarkable differences; whilst in the case of most areas their average weight is over 1000 gm., in the three areas B_3, C_3 and B_2 it is only 372, 356 and 467 gm. These are the three areas in which the larger proportion of plaice landed are fished by the sailing-vessels of Lowestoft; here, therefore, the Lowestoft method of sorting, which is quite different from that in other ports, has the most influence.

It is clear from this, however, that to found any judgment as to the composition of the landings on the market-classes alone, would lead to results which are not at all comparable for the different areas and quite wrong with regard to the landings from the whole North Sea. It is thus absolutely necessary that the plaice of the landings *should be measured singly*.

As an aid to understanding the general lines of the further analysis and as basis for many of the subsequent discussions I give here the following summary Table from Vol. III of the "Plaice Fisheries", showing the size and composition of the English plaice landings during the period October 1905/08, arranged according to areas and market-classes. With regard to the corresponding sizes and composition of the samples measured, reference may be made to Vols. I and II of the same Report.

1. With regard now to the proportion of the quantity (by weight) of plaice samples measured to quantity landed, we have the following information. From the areas A_3 and B_4, which are practically united, 0.85 per cent by weight of the total landings have been measured; from B_3 2 %, from B_2 1 %, from C_3 2 %; from these 5 areas, which form the region of the small plaice, altogether 1.4 %. From the area B_1 0.8 %

Table 1. English market-measurements. Quantities of plaice landed in English ports by first-class vessels from each area of the North Sea during the period October 1905 to end of September 1808, with the percentage of each trade category (83).

Area	Quantity Landed					Percentage of Total Quantity in each Trade Category			
	Large	Medium	Small	Size not distinguished	Total	Large	Medium	Small	Size not distinguished
	Kilos.	Kilos.	Kilos.	Kilos.	Kilos.	Per cent.	Per cent.	Per cent.	Per cent.
A_1	40,792	110,489	72,085	305	223,671	18.24	49.40	32.23	0.1
A_2	—	—	508	3,404	3,912	—	—	12.99	87.0
A_3	61,468	698,855	5,594,478	140,386	6,495,187	0.95	10.76	86.13	2,1
A_4	—	—	—	—	—	—	—	—	—
Total A. .	102,260	809,344	5,667,071	144,095	6,722,770	1.52	12.04	84.30	2.1
B_1	4,491,330	1,124,763	167,030	319,939	6,103,062	73.59	18.43	2.74	5.2
B_2	3,458,515	3,676,244	2,644,039	60,096	9,838,894	35.15	37.37	26.87	0.6
B_3	4,639,462	4,777,486	8,676,945	2,439,924	20,533,817	22.59	23.27	42.26	11.8
B_4	431,089	2,426,411	9,330,410	84,912	12,272,822	3.51	19.77	76.03	0.6
B_5	226,112	241,655	698,957	213,156	1,379,880	16.39	17.51	50.65	15.4
Total B. .	13,246,508	12,246,559	21,517,381	3,118,027	50,128,475	26.43	24.43	42.92	6.2
C_1	1,662,581	1,067,664	276,049	1,625	3,007,919	55.27	35.50	9.18	0.0
C_2	5,552,643	5,817,058	4,493,411	2,382,115	18,245,227	30.44	31.88	24.63	13.0
C_3	3,364,383	843,228	1,996,948	254,914	6,459,473	52.08	13.05	30.92	3.9
Total C. .	10,579,607	7,727,950	6,766,408	2,638,654	27,712,619	38.18	27.89	24.41	9.5
D_1	485,725	537,820	93,903	70,053	1,187,501	40.90	45.29	7.91	5.9
D_2	1,110,996	334,873	27,077	70,155	1,543,101	72.00	21.70	1.75	4.5
D_3	4,623	9,144	356	—	14,123	32.73	64.75	2.52	—
Total D .	1,601,344	881,837	121,336	140,208	2,744,725	58.34	32.13	4.42	5.1
Total E. .	185,826	277,520	30,430	3,353	497,129	37.38	55.82	6.12	0.6
F_1	22,809	21,896	1,523	—	46,228	49.35	47.37	3.29	—
F_2	—	102	—	—	102	—	100.00	—	—
Total F. .	22,809	21,998	1,523	—	46,330	49.23	47.48	3.29	—
Total G. .	—	—	—	—	—	—	—	—	—
Total all Areas . .	25,738,354	21,965,208	34,104,149	6,044,337	87,852,048	29.30	25.00	38.82	6.8
Areas not distinguished	941,477	1,124,255	1,812,646	559,105	4,437,483	21.22	25.33	40.85	12.6

have been measured, from C_1 1 %, from C_2 1.5 %, from $D_1 + D_2$ 1.6 %; from these 5 areas, which form the region of the large plaice, altogether 1,3 %. It will be seen, that the difference in the percentages measured from each area is not great. These vary from 0.85 to 2 % and are practically the same (1.3 and 1.4 %) when the areas are grouped together into the region of small plaice and the region of large plaice respectively. In this connection, therefore, the selection of the samples is satisfactory.

2. *Proportion of the market-classes in the samples and in the landings.* For the samples to be representative it is essential, that the different market-classes should be in the same proportion in the samples as in the total landings, or in other words, an equal percentage must be measured of each market-class in the landings, and, naturally, for each port separately, since the ways of sorting are different in each port. The result of such an analysis, for all months and areas together, and for each year and port, is as follows.

Table 2. English market-measurements. Proportion of plaice weighed and measured in each class to the total landings (84).

(*a*) GRIMSBY

Period	Proportion Weighed and Measured		
	Large	Medium	Small
	Per cent.	Per cent.	Per cent.
I. October, 1905—September, 1906	0.06	0.51	1.32
II. October, 1906—September, 1907	1.01	1.29	1.07
III. October, 1907—September, 1908	0.59	0.88	0.72

(*b*) LOWESTOFT

Period	Proportion Weighed and Measured			
	Large	Medium	Small	Others
	Per cent.	Per cent.	Per cent.	Per cent.
I. October, 1905—September, 1906 . .	1.41	0.09	3.07	6.13
II. October, 1906—September, 1907 . .	2.19	—	2.01	4.31
III. October, 1907—September, 1908 . .	1.99	2.68	1.95	2.65

(*c*) BOSTON

Period	Proportion Weighed and Measured			
	Large	Medium	Big-Small	Small
	Per cent.	Per cent.	Per cent.	Per cent.
II. May, 1906—March, 1907	28.60	33.63	2.19	6.75
III. April, 1907—March, 1908.	38.27	34.74	16.60	5.83

In the first year (October 1905/06) the proportion of the different market classes measured is so different, both in Grimsby and Lowestoft, that the samples of this year can scarcely be taken as representative. Far too many "small" plaice relatively have been measured, especially in Grimsby where the greatest quantities are landed. The reason for this is, that in the beginning of the work in October 1905 the intention during the first months was to measure the small plaice only and it was only later, that all sizes of plaice came to be dealt with equally. On the whole also, it was only from the second year onwards that the work of measurement could be carried out regularly and with sufficient care. The percentages for the second and third years are indeed, as a matter of fact, very satisfactory; in Grimsby they only differ from one another by at most $^3/_{10}$ths of their average value. In Lowestoft the proportions are even more in agreement, when we remember, that the class "medium" is of no importance here and the "others" in reality not a market-class, but unsorted fish.

In *Boston,* as will be seen, a very much larger percentage of the landings has been measured than in the two other ports. In consequence of this, although the total landings of Grimsby and Lowestoft in proportion to those of Boston are as 54 and 20 to 3.4, the absolute number of plaice measured in Boston is very considerable and amounts to about $^1/_3$ to $^1/_2$ of the number for Grimsby and Lowestoft together. In the case of the Boston measurements it is only for the period April 1908 to March 1909, that representative proportions of the three classes large, medium, big-small + small, have been measured; in the other two periods, from April 1907/08 and especially from May 1906 to March 1907, relatively far too many large and medium plaice have been measured.

The fact, that relatively far too many small plaice have been measured in Grimsby and Lowestoft during the first year of the English measurements, in Boston conversely relatively too many large, brings about a certain, not inconsiderable amount of compensation or balance, though certainly not perfect. On the other hand, we may ascribe to the measurements of 1906/07 and 1907/08 a much higher and in general — taking the years as a whole without attention to months and areas — a satisfactory representative value.

The question of a correct, representative composition of the samples measured is much more difficult, when we come to deal with the separate months and areas.

Table 3. English market-measurements, Grimsby and Boston; 1906/07 and 1907/08. Proportion by weight of the three market-classes large, medium and small in the landings and in the samples measured for each month.

		Grimsby							Boston							
		1906/07				1907/08				1906/07				1907/08			
Month		l. %	m. %	s. %		l. %	m. %	s. %		l. %	m. %	s. %		l. %	m. %	s. %	
October . .	land.	39	32	29	land.	22	29	49	land.	26	21	53	land.	15	12	77	
	meas.	18	24	58	meas.	23	40	37	meas.	45	28	27	meas.	33	16	51	
November.	land.	25	28	47	land.	23	28	49	land.	34	21	45	land.	20	10	70	
	meas.	52	25	23	meas.	32	33	35	meas.	56	21	23	meas.	45	12	43	
December .	land.	29	36	35	land.	25	30	45	land.	37	22	41	land.	21	9	70	
	meas.	27	21	52	meas.	27	29	44	meas.	59	24	19	meas.	45	11	44	
January. . .	land.	35	45	20	land.	32	36	32	land.	35	28	37	land.	42	13	55	
	meas.	26	47	27	meas.	20	39	41	meas.	59	30	11	meas.	44	10	46	
February. .	land.	40	42	18	land.	41	35	24	land.	33	29	38	land.	42	25	33	
	meas.	34	38	28	meas.	34	34	32	meas.	51	27	22	meas.	46	16	38	
March. . . .	land.	41	38	21	land.	37	33	30	land.	26	22	52	land.	28	16	56	
	meas.	31	32	37	meas.	20	24	46	meas.	40	19	41	meas.	30	17	53	
April	land.	33	30	37	land.	21	29	50	land.	16	11	73	land.	8	7	85	
	meas.	23	34	43	meas.	12	34	54	meas.	26	22	52	meas.	13	14	73	
May	land.	22	28	50	land.	20	30	50	land.	23	14	66	land.	22	9	69	
	meas.	19	34	47	meas.	13	42	45	meas.	53	12	35	meas.	45	9	46	
June	land.	24	27	49	land.	28	35	37	land.	27	10	63	land.	7	3	90	
	meas.	15	36	49	meas.	14	46	40	meas.	55	10	35	meas.	25	6	69	
July	land.	18	26	56	land.	28	34	38	land.	15	12	73	land.	14	9	77	
	meas.	9	42	49	meas.	13	43	44	meas.	28	15	57	meas.	20	14	66	
August . . .	land.	20	30	50	land.	26	33	41	land.	18	18	64	land.	7	7	86	
	meas.	12	42	42	meas.	13	46	41	meas.	30	20	50	meas.	15	11	74	
September	land.	16	29	55	land.	22	31	47	land.	14	7	79	land.	7	7	86	
	meas.	13	38	49	meas.	10	31	59	meas.	31	15	54	meas.	12	21	67	
All 12 months	land.	26	30	44	land.	25	30	45									
	meas.	23	35	42	meas.	20	37	43									
Absolute quantities for the year in kg.	land.	16,913,616			land.	17,332,073			land.	880,516			land.	1,272,235			
	meas.	188,253			meas.	127,532			meas.	142,596			meas.	153,551			

With regard, first of all, to the composition of the samples measured in the different months of the year, Table 3 permits of an examination of this question. If we take in turn the two ports Grimsby and Boston, which have almost the same method of sorting the catches, we find very considerable differences between the proportions of the

monthly landings and monthly measurements. In Grimsby for both years and for almost all months, especially from March to September, far too few large plaice have been measured in proportion to the landings and, conversely, too many small in most months. The only months with a satisfactory representative character are May 1906/07 and December 1907/08. In Boston we have the reverse condition to Grimsby; far too many large plaice have been measured in all months, often more than double the proportion in the landings and, correspondingly, far too few small.

These differences between the landings and the market-samples are so great, that the mixed series of measurements cannot possibly give a correct picture of the composition of the landings in the different ports. Fortunately, however, these differences are for the most part eliminated or smoothed, *when both ports are taken together*. This can and must be done without scruple; since, though the quantities landed in the small plaice port Boston only amount to about 1/18th of the landings in the large port Grimsby, yet a much greater percentage of the landings has been measured in Boston than in Grimsby (see pp. 71—2) and, consequently, the absolute quantities of plaice measured in the two ports are approximately the same in both years. As relatively more large plaice have been measured in Boston and relatively more small in Grimsby, the one may be taken to counterbalance the other. The manner and extent of this counterbalance may be seen from the two following examples, October 1906 and June 1908:

			% large	% medium	% small
October 1906	Grimsby	land.	39	32	29
		meas.	18	24	58
	Boston	land.	26	21	53
		meas.	45	28	27
	Grimsby + Boston	land.	38	31	31
		meas.	35	27	38
June 1908.	Grimsby	land.	28	35	37
		meas.	14	46	40
	Boston	land.	7	3	90
		meas.	25	6	69
	Grimsby + Boston	land.	21	27	52
		meas.	20	24	56

It will be seen, that the incongruences are smoothed out to a very great extent; throwing together the two ports we obtain, in fact, a very satisfactory agreement between landings and measurements.

In the case of Lowestoft with its different method of sorting from Grimsby and Boston, the unsorted samples (others) do not come into consideration for an analysis such as the above; the "medium" are somewhat smaller than the large. The best thing to do

here is, to investigate how far the proportions of large and medium to small are the same in landings and measurements in the different months. Such an analysis for 1097/08, based on the Tables XLVI and LV in Vol. II of the "Plaice Fisheries", has given a good correspondence in most of the months.

Taking all three ports together, the composition of the market-samples, in regard to relative proportions by weight of the market-classes, may thus be taken as sufficiently representative for the different months, at least for the years 1906/07 and 1907/08, when the method of measurement had been well-developed. The correspondence becomes still greater, when we combine together the monthly measurements of these two years.

There remains now to examine the relation between the measurements and the landings from the different *areas* of the North Sea.

Table 4. English market measurements. Proportions by weight of the three market classes large, medium, small in the landings and samples measured in the three years 1905/08 for the different areas (all ports combined) (86).

Area	1905/06				1906/07				1907/08			
		l. %	m. %	s. %		l. %	m. %	s. %		l. %	m. %	s. %
A_3	land.	2	14	84	land.	1	7	92	land.	—	13	87
	meas.	—	31	69	meas.	—	39	61	meas.	1	45	54
B_4	land.	2	21	77	land.	5	18	77	land.	3	22	75
	meas.	—	20	80	meas.	11	36	53	meas.	12	34	54
B_3	land.	37	26	37	land.	26	26	48	land.	19	27	54
	meas.	27	13	60	meas.	32	17	51	meas.	24	24	52
C_3	land.	65	10	25	land.	51	18	31	land.	48	12	40
	meas.	66	2	32	meas.	66	2	32	meas.	55	5	40
C_1	land.	55	37	8	land.	54	38	8	land.	57	33	10
	meas.	31	65	3	meas.	49	34	17	meas.	35	41	24
C_2	land.	45	35	20	land.	36	39	25	land.	25	36	39
	meas.	27	44	29	meas.	41	23	36	meas.	25	20	55
B_1	land.	72	25	3	land.	89	9	2	land.	76	20	4
	meas.	60	26	14	meas.	81	8	11	meas.	44	23	31
B_2	land.	36	41	23	land.	33	28	29	land.	36	30	34
	meas.	13	32	55	meas.	25	30	45	meas.	31	25	44

From Table 4 it will be seen, how far the measurements and landings agree in composition for the different areas (D and E areas being omitted), taking each year separately. It appears that the correspondence, with few exceptions, is too *insufficient* to enable the measurements to be regarded as directly *representative* for the different areas. In detail we have the following results. In those areas in which the small plaice occur in greatest quantity, both relatively and absolutely, and far exceed all other classes, namely A_3 and B_4, *too few small plaice* in proportion to the landings

have been measured in all three years. In the areas B_3 and C_3, where the small plaice no longer exceed in quantity the other classes together, but almost equal or are slightly less than these, we find, with exception of B_3 in 1905/06, a very good agreement between landings and measurements. In the areas $C_1 — C_2 — B_1 — B^2$, where the small plaice are considerably less in quantity than the larger, *too few small* plaice have been measured in all three years.

These obvious imperfections in the selection of the market-samples according to areas may perhaps be explained on the basis, that in the collection of the samples a natural tendency has been present to take account of the different classes large, medium and small as far as possible to an equal extent; the above result would almost necessarily follow from this. Thus, in area B_4, for example, from which very great quantities of small are landed in proportion to medium and large, even a very slight tendency to pay equal attention to the three classes on measuring must have the result, that too few small are measured. In order to obtain representative values here, a tendency to measure more small would have been very useful. This tendency has in fact existed in the year 1905/06 for other reasons, as already mentioned, and thus it happens, that the measurements for that year from the areas A_3 and B_4 have a greater representative value than in the other two years, as will be seen directly from the Table. A smoothing out of this imperfection in the representative value of the measurements for the different areas would only be possible, if we took the measurements of the three years 1905/08 together or the average of these. Since, however, the lack of correspondence for the areas tends almost always in the same direction in all three years, this smoothing process can only be imperfect and the too great or too weak representation of small plaice in certain areas will only be diminished, but not removed. For example, we have for the 3 years:

		%	%	%
Area B_4	landed	3	20	77
	measured	6	30	64
» B_3	landed	26	26	48
	measured	28	18	54
» C_2	landed	35	27	28
	measured	31	26	43

The final result of the analysis, how far a correct selection of the English samples for the use of mixed series has been made, is the following.

In the different months and years fairly considerable differences sometimes exist between the samples measured and landings in the various ports and these differences often very greatly reduce the representative value of the single samples. If, however, we combine the landings and measurements of the different ports, months and years, the differences counterbalance one another so much, that sufficiently representative series are obtained in most cases. Two important incongruences still remain, however; firstly, there has been a marked tendency in the first year, especially in the first months, to measure chiefly the small plaice. In consequence, there is no doubt that the average

size of all the plaice measured in the year 1905/06 is too low; on the other hand, just in consequence of this tendency to measure many small plaice, the measurements for the areas A_3 and B_4, the areas of many small plaice, have become representative to a very satisfactory degree. Secondly, there has been an unconscious tendency in the other two years 1906/07 and 1907/08 to pay equal attention on measuring to the different classes; with the result, that in the areas A_3 and B_4, with very many small plaice, relatively too few and in other areas with very few small plaice relatively too many small plaice have been measured. This remarkable incongruence remains even on combining the three years and is only reduced in the case of the areas A_3 and B_4. In estimating the representative value of the results for the different areas this fact must also be remembered. If the measurements for all areas are combined, thus, all the landings from the North Sea in English ports dealt with as a whole, a smoothing of differences takes place in such a way, that the too many small plaice measured for certain areas are compensated by too few measured for other areas. In the case of the two years 1906/07 and 1907/08, which we may call the normal years of measurement, this has led to satisfactory, representative series (Appendix Tables XV and XVI), that is, series in which, we may believe, there is a similar mixture of the different plaice as in the total landings. It must be repeated once more, however, that we cannot expect, in reality, that the certainty in the average values of these series can be so great as that obtained from the purely theoretical calculation of their probable error; these values must rather be considered as reliable only within the range of at least one whole centimetre. For the year 1905/06, the abnormal year of measurement, there is always a surplus of small plaice in the series of total measurements (Appendix Table XIV), which reduces their representative value.

Strictly speaking, we have only to do with the landings in the three ports mentioned, when examining into the representative character of the English measurements. In nevertheless including the total landings in all English ports in the comparison of landings with measurements, this has been done on the supposition, that the landings in the three ports are or may be representative for all ports. As already indicated (p. 63), this is probably not quite the case, for the very important market for plaice, London, could not be included in the system of measurements. London receives not only very considerable quantities of plaice from the North Sea (the largest quantities after Grimsby and Lowestoft, about 15 % of the total landings), but of all English ports London is the one at which by far the largest, relative quantities of small plaice are landed; over 60 % of its total landings. These come mainly from the small plaice areas of the southern North Sea in the months of May to July (87). There can be no doubt, therefore, that the small plaice would appear more numerous in our series than they do, if London had been suitably represented in the measurements. The series of measurements for the two normal years 1906/07 and 1907/08 would then probably approximate to the series of the abnormal year 1905/06, which has a larger representation of small plaice; to what extent, however, cannot be determined. It is nevertheless conceivable, that the series for 1905/06 might correspond better to the composition of the landings of all ports, including London, than the series for the two other years.

For this reason I have considered it useful and best to take together the three

series of measurements for the years 1905/08 in the following discussion of the results of the English market measurements. This is permissible, since the total number of plaice measured in each of the three years is approximately the same. Of the total number measured in the period October 1905/08, altogether about 4,926,000 plaice, 1,553,000 belong to the first year, 1,776,000 to the second, and 1,597,000 to the third. The various values in the combined series for three years may therefore be regarded as the averages for the three years when divided with 3; I have not done this, as it meant unnecessary work and makes no difference in the calculation of the relative values. That such a three-years' series has theoretically a higher value than a series for a single year is evident, among other reasons, because it levels out many irregularities and accidents of various kinds, especially in the selection of the market-samples.

4. *Results of the English market-measurements.* As already mentioned, MASTERMAN in discussing the results of the English market measurements in his Report restricts himself to the calculation of only some values, in addition to the total number, of the summary series representing the composition of the landings by length and weight, namely, the percentage by number and weight of the plaice below certain lengths, 20, 23, 26 and 29 cm.

The following discussion of the results of the English market-measurements goes much further than MASTERMAN; it shows the mixed series constructed by me in the whole of their extent and thus enables a picture to be formed of the composition of the landings from cm. to cm.

In the discussion of these series and their graphic representation I have only dealt, in the majority of cases, with the series as *summation series or summation curves,* in the manner indicated above in Chap. I, 3, p. 56; mostly, also, in the abbreviated form, only some of the characteristic values of the series being calculated, namely, the central or median value (C, M), quartiles, deciles and upper vigintile. This procedure is indispensable for the principal conclusions to be drawn from the material, since for practical purposes, e. g. the choice of a size-limit, we must know above all, how many plaice both by number and weight occur in a series below a definite length.

In using the summation curve (usually also the ordinary form of curve) it is advisable to have the series not only in absolute numbers, but also in *relative,* i. e. with reference to the same unit, and thus to construct the so-called percentual curves. This has been done here in fullest extent, with the small, but very convenient alteration, that the absolute numbers are reduced to a total number not of 100 but of 1,000,000. In most Tables, indeed, only this per million series is given and only the total sum of the series as absolute number.

The use of the summation curve also presents the possibility of displaying in a very simple, graphic manner the essential differences between such curves, for example, within the same area for the different months of the year or within the same month for different areas. For example, fig. 19 shows the changes in the summation curve during the twelve months of the year for the area B_4, based on the averages for the three years 1905/08. The abscissa is divided into 12 equal parts, the 12 months, the ordinate into the lengths of plaice from 0 to 70 cm. On the lines drawn through the

monthly points on the abscissa parallel to the ordinate the following values have been marked for each month, from below upwards: lower extreme, lower decile, lower quartile, median (central value), upper quartile, upper decile, upper vigintile, upper extreme. If we now draw straight lines through the similar points for all 12 months we can follow in a very clear manner the rise and fall of the similar values from month to month. For reasons to be explained later, the series of months begins with November and ends with October.

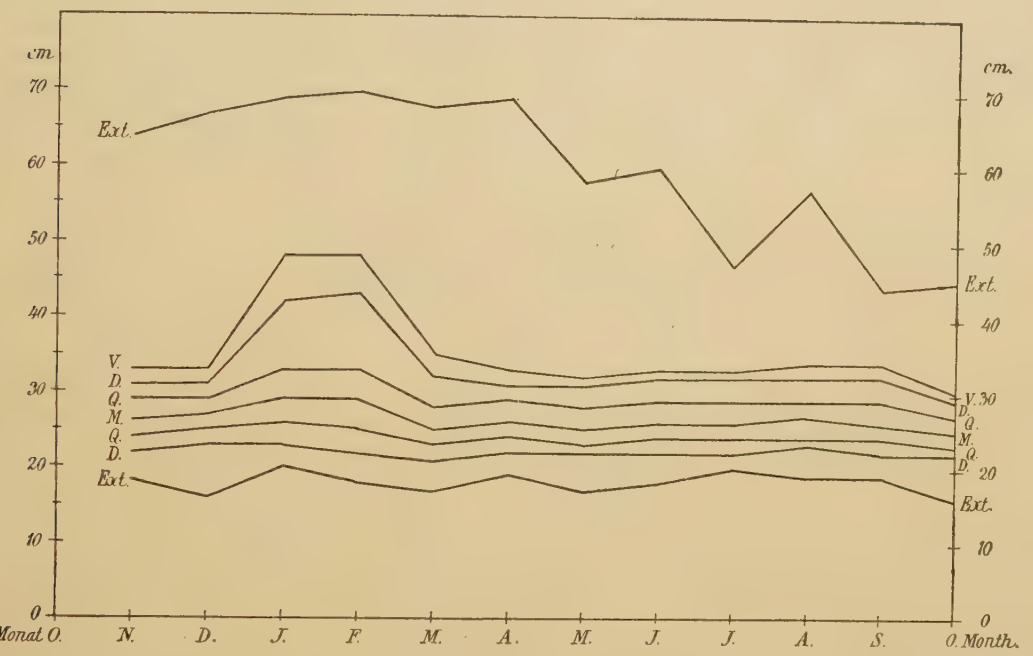


Fig. 19. English market-measurements of 1905/08 for the area B4. Fluctuation of the principal values in the summation series from month to month. Ext.: extreme values; V: vigintile; D: deciles; Q: quartile; M: median.

This mode of representation shows very distinctly among other things the following points; on the one hand, the slight change in the principal values during the months of March to November — shown by the almost parallel course of the connecting lines — and on the other hand, the sudden rise in these values during the winter months, especially in January and February, a characteristic indication, that relatively many fewer small and more large plaice are present in the landings of these months than in the summer landings The predominant range, which lies between the two quartiles and embraces half (50 %) of all the plaice in the series, remains almost unchanged at 24 to 29 cm. from March to November, but is from 25 to 33 cm. in January and February. Correspondingly, the larger and large plaice over 35 cm. compose at most 5 % of the total landings in the months of April to December, but 25 % in January and February.

The change in the values of the series from month to month becomes even more

clearly represented, if, instead of drawing the lines, on which these monthly values are marked, parallel to the ordinate and to one another, we draw them as radii of an annual cycle. In this way the end of the year joins directly on to the beginning and we can follow all the changes in the composition of the landings in their natural, cyclic order. I have made extensive use of this special mode of representing such data in this Report, as the Plates will show.

Fig. 20 gives a second example of representing the measurement series graphically. Here the summation-curves of the different areas constructed from the measurements of all three years and all months are compared with each other. It can be seen at a glance from these, how the average size of the plaice steadily increases with the depth of the areas and their distance from the coast and, correspondingly, how

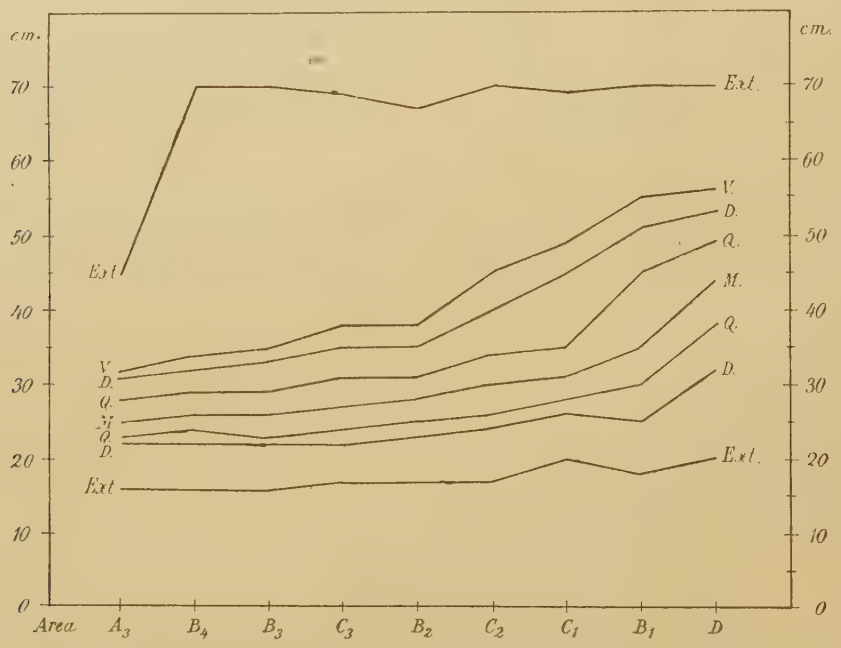


Fig. 20. English market-measurements of 1905/08. Comparison of the principal values of the summation curve derived from the measurements of all months for each area. The areas are arranged from left to right according to their natural position relative to depth and distance from the coast.

the small plaice show a steady decrease. In area A_3, for example, 50 % of all plaice in the landings are smaller than 25 cm., but in area B_1 only 10 %. In the areas A_3 and B_4 75 % of all plaice are below 28 to 29 cm. and 90 % below 31 to 32 cm., in area B_1, however, only 25 % are under 30 cm. and 75 % are over that length. These comparisons of the areas may be made even more conveniently and comprehensively in the cyclic form of graphic representation (cf. Plates II—IV).

a. Composition of the landings from the various areas.

The mixed series of measurements for the various areas have naturally been taken separately for each year, but only the combined series for all three years October 1905/08 are reproduced here. As already explained above, p. 74, the representative value of these series for the various areas is affected by the fact, that the percentages by weight of the market-classes measured are not in sufficient agreement with those in the landings. The greater this discordance between the relative quantities in the measurements and landings for an area, the less is the representative value of the series concerned, and the greater is the uncertainty in the single, principal and summation values. Fortunately, however, it is possible to some extent to estimate the degree of incongruence and to correct certain defective values of the series, for example, the summary values, approximately and sufficiently in many cases. The method of applying this correction will be shown under the example for the area A_3. For the purpose of displaying its application — here to the total sum of the landings — the discussion of each area will be preceded by a tabular summary of the following data and calculations:

1. Absolute quantities (in kg.) of the various market-classes of plaice landed in England from the area in question during the three years' period (88).

Relative quantities of the market-classes (percentages).

2. Absolute quantities of all samples of the market-classes in these landings, weighed and measured in all ports and all months. Relative quantities do. (percentages) (89).

3. Numbers of plaice measured in each market-class. Relative numbers do. (percentages) (89).

4. Average weight (g) of the plaice measured in each market-class (weight of each class divided by the number).

5. Average weight of plaice measured without distinction of classes (weight of all plaice measured divided by their number).

6. Estimated number of each market-class in the landings, calculated from the total weight landed divided by the average weight of plaice measured of each class. Summation of these numbers for each class to give the total number in the landings. Relative proportions of the numbers for the different classes.

7. Estimated average weight of all plaice landed (total weight of all the landings divided by the estimated total number).

8. Estimated total number of the landings without distinction of market-classes. Calculated from the total weight of the landings of all classes together divided by the average weight of all the measurements (5).

The values indicated in (5) and (8) are obtained from the mixed series of measurements calculated according to my method; those of (6) and (7) result from the method adopted by MASTERMAN. The former are affected by errors of incongruence between the relative quantities measured and landed, the latter not; the latter, consequently, are the more certain and may be taken as the *probable* (w) values.

It must be emphasized again here, that in the case of the different areas the plaice measurements are always taken to refer to the total landings in all English

ports; these total quantities are given in the Table p. 70 for the period 1905/07. On the other hand, the values calculated by MASTERMAN for the different areas etc. only refer to the landings in those ports in which samples were measured.

1. Area A_3. *0—20 m. South-eastern North Sea.* 4,800 square miles.

The English landings and measurements for the period October 1905/08 (see Table 1) amounted to:

Area A_3 1905/08	large	medium	small	size not distinguished	Total
	kg.	kg.	kg.	kg.	kg.
Landed	61,468	698,855	5,594,478	140,386	6,495,187
%	0.95	10.76	86.13	2.16	100.00
	kg.	kg.	kg.	kg.	kg.
Measured	52	15,254	24,690	—	39,996
%	0.1	38.1	61.8	—	100.00
	nos.	nos.	nos.	nos.	nos.
	32	53,869	171,560	—	225,451
%	0.01	23.90	76.09	—	100.00
Average weight of the plaice measured.					
	kg.	kg.	kg.	kg.	kg.
a. classes distinguished	1.625	0.283	0.144	—	—
b. total	—	—	—	—	0.177
Estimated numbers of plaice landed, calculated from $\frac{\text{landings kg.}}{\text{average of measured kg.}}$					
	nos.	nos.	nos.	nos.	nos.
a. classes distinguished	37,826	2,469,452	38,850,542	914,010	42,271,830
b. size not distinguished omitted	37,826	2,469,452	38,850,542	—	41,357,820
%	0.09	5.97	93.94		100.00
c. classes not distinguished				Average weight kg. 0.153	36,695,972

The product of the English plaice fishery from area A_3 is considerable; of the 9 other areas dealt with only B_2, B_3, B_4 and C_2 yield greater quantities. The English plaice fishery in this area is only carried on by steam-trawlers, and only from London and Grimsby. The catch per day of voyage of the trawlers is given by MASTERMAN as 492 kg. (90) for the period 1905/08, that is, higher than for any other area. This is an indication of the great density of the plaice caught here.

If the plaice measurements for this area, the analyses of which for the separate months and for all three years together are given in Appendix Table I, were directly representative in their composition for the landings, then an average weight of 177 gm. per plaice calculated from these measurements would by reference to the total landings of 6,495,187 kg. give the total number of plaice landed as 36,695,972. But it is ob-

vious, that far too few small plaice (and too many medium) have been measured and the average weight per plaice would certainly be smaller in the landings than in the samples measured. The total numbers in the landings would therefore be more accurately estimated, if we determined the average weight of each class separately from the market-measurements, thence calculated the total numbers for each market-class in the landings and added these together. As the class "unsorted" occurs in the landings, but not in the measurements, its number of specimens must be calculated by comparison of the weight with the total of the other classes in the landings, on the assumption, that the unsorted have just the same composition as the other three classes combined. The 140,386 kg. of unsorted in the landings would thus give 914,010 plaice, and including this amount we obtain for the total number of plaice in all landings from A_3 in the three years, approximately 42,272,000 plaice or excluding this amount roughly 41,358,000. The unsorted plaice are thus obviously of little importance by comparison with the differences, which are present owing to too few small plaice being measured. We need therefore only deal with the two totals of 36,695,972 plaice (calculated from the measurements) on the one hand and 41,357,932 plaice (calculated from the market-classes and measurements) on the other. The former may be called the estimated, the latter the *probable* number of specimens. If we take the first as 1, the second is 1.13. The differences are thus not inconsiderable, the probable number being 13 % higher than the estimated.

Table 5. Area A_3. English market-measurements 1905/08.
Principal values of the summation curves.

Month	Ext.	D.	Q.	M. C.	Q.	D.	V.	Eks.
November	17	20.97	23.00	26.04	29.22	31.80	33.23	41
December	19	21.25	22.88	25.63	28.19	30.45	31.83	38
January	—	—	—	—	—	—	—	—
February	19	21.00	22.64	24.94	26.97	29.38	31.27	38
March	18	20.04	21.73	25.27	29.80	32.31	33.56	38
April	16	21.33	22.81	25.16	28.40	31.20	32.72	39
May	19	21.65	23.21	25.29	28.00	30.65	32.11	45
June	18	22.07	23.39	25.29	28.01	30.55	30.92	43
July	18	22.90	24.45	26.31	28.80	31.07	32.38	38
August	18	21.12	23.27	25.24	28.07	32.04	33.55	39
September	19	22.56	24.07	25.90	28.34	30.48	31.60	39
October	19	21.07	21.94	23.21	24.37	25.76	26.58	30
3 years	16	*m* 21.75	23.30	25.44	28.23	30.81	32.27	45
		w	22.84	24.56	26.51			
Averages for four months.								
I. Spring	18	21.27	22.79	25.25	28.55	31.18	32.11	41
II. Summer	18	21.91	23.43	25.16	27.40	29.84	31.03	37
III. Winter	19	21.07	22.84	25.34	28.13	30.54	32.28	39

The accompanying Table 5 gives a summary of the principal values of the summation curve for each single month and for the whole year (all as the sum for 3 years). The averages for each four months (third of the year) are also calculated. These four-monthly periods are I. *spring* (March to June); II. *summer* (July to October); III. *winter* (November to February). They correspond to certain divisions of the biological year of the plaice (cf. p. 22). The measurements for the different months are unfortunately incomplete; thus, there are no measurements at all for January in all three years and most of the other months are only represented by one or two years; only the months of April to June are present in all three years. The values of the Table 5 are thus not very representative.

Fig. 1 A_3 on Plate I gives the principal values of the summation curve arranged according to the cyclic method.

The composition of the landings from A_3 gives the following picture. The lengths of the plaice lie between 16 and 45 cm. (a few larger plaice caught in March 1908 have been omitted). In the summation curve of the whole year we find:

below	23	25	26	29	31	35 cm.
	22 %	44 %	55 %	72 %	90 %	99 %

In the sequel we may call the plaice below 25 cm. as "*undersized*" and the plaice below 29 cm. "*small*"; the latter might in fact correspond in numbers to what are taken as "*small*" in the English method of sorting. The plaice above 35 cm. may be called "*large*" or even better "*certainly mature*", since we may assume, that by 35 cm. not only all the male but practically all the female plaice of the North Sea have reached the spawning age.

In the case of area A_3 it is obvious that too few small and too many medium plaice have been measured (owing to their small numbers the class "large" does not come into consideration); of the small only 61.8 per cent by weight against 86.13 in the landings, of the medium 38.1 per cent by weight against 10.76 in the landings. This incongruence between measurements and landings is considerable, as appears already from the great difference between the two total numbers calculated from the measurements and landings respectively. The single values of our mixed series for A_3 given in Appendix Table I and, correspondingly also, all the values of the summation curve calculated from them (Table 5) are insufficiently representative and affected by a *considerable error*. The median and the other related, principal values of the series, as the quartiles and deciles, must be lower in reality than our tables represent; the single values for the different lengths will be higher in the landings in the case of the smaller plaice and in the case of the larger lower than in the series of measurements; lastly, all the summation values from the beginning of the series, the lowest length, onwards, thus e. g. all under 25 cm., 29 cm. and so on, will be too low in the measurement series and must be made higher in the landings.

These last values in the summation series may however be corrected approximately, As shown above (p. 82), the proportion between the numbers of medium and small, the only classes we need consider here, is as 24 to 76 approximately in the measurements. but as 6 to 94 probably in the landings; the proportion between the number of small

plaice in the total estimated from the measurements without consideration of the market-classes (36,695,972) and their number in the probable total (41,357,820) is as 76 to 94 and the number of medium-large conversely as 24 to 6. We may now assume, that the 76 % of small plaice in the mixed series of measurements are similarly composed, in regard to the numbers at different lengths, to the 94 % of small in the probable total of the landings, that is, we may presuppose, that relatively just as many or about as many plaice are, for example, below 26 cm. among the 74 small plaice measured as among the 94 small plaice of the landings. Under these circumstances the 55 % of plaice below 26 cm. in the measurement-series changes to $\frac{55.94}{76} = 68$ % in the probable series of the landings. The 22 % of plaice below 23 cm. becomes 26 % and so on for the other totals of the small plaice. Similarly, if we assume the same composition for the 24 % and 6 % of the large plaice and begin the summation for the larger plaice from the upper end of the series, we obtain, for example, for the number of large plaice above 31 cm., instead of 10 % the number $\frac{10.6}{24} = 2.5$ % and similarly for the plaice below 31 cm. instead of 90 % the number 97.5 % and so on.

In this way we may construct the two following series of percentages of the summation curve; *m* is the value calculated from the summation series of the measured plaice, *w* the probable or, paying attention to the proportions between the market-classes, the corrected value.

below	23	25	26	29	31	36 cm.
m	22 %	44 %	55 %	79 %	90 %	99 %
w	26 -	55 -	68 -	95 -	97.5 -	99.8 -

The median and the other values of the summation curve may be approximately corrected in the same way. The median indicates the point of the curve, above and below which lie 50 % of the total number of plaice. In the 3 years' series for A_3 the median is 25.44 cm. In the probable series for the landings it must lie at a lower level, as the number of small plaice is relatively greater. 50 % in the landing series would only be $\frac{50.76}{94} = 40$ % approximately in the measurement series. 50 % in the measurement series (Appendix Table 1) corresponds to a value of 25.44 cm., 40 % to a value of 24.56. This would therefore be the probable median or central value for the landings; it is almost a whole centimetre lower than the measured median. The lower quartile of 23.30 in our measurement series becomes reduced in a similar way to 22.84 cm.; the upper quartile from 28.23 to 26.51. The predominant range of the landings thus lies probably between 22.84 and 26.51 instead of between 23.30 and 28.23 as in the measurement series.

Lastly, the single values of our measurement series may also be corrected. In correcting each single value of the summation series (for each cm.), we construct the whole, probable summation series and from this, by means of the differences between the separate items, the whole probable percentage series.

As already remarked, the correction thus introduced is only *approximate*. For

reasons that need not be discussed here, it often gives insufficient values, especially for the middle part of the curve. Further, it is only of much practical use, when the different market-classes are only arranged in *two groups*, here, for example, in large + medium and small. Lastly, it may also lead to inaccurate values, when the average weights of the market-classes, which are combined into one group, are very different. Nevertheless, in most cases, especially when the incongruence between measurements and landings is not too great, for example, not so great as here in A_3, it gives approximate values which can be used for our practical purposes.

We may now compare this result obtained from our mixed series with the values calculated by MASTERMAN on his method.

MASTERMAN gives the following calculations (91):

Area A_3	Estimated total number of plaice landed	under 23 cm.	under 26 cm.	under 29 cm.
I. Oct. 1905/06 3 months April to June	4,755,680	28 %	65 %	88 %
II. Oct. 1906/07 12 months	6,546,444	23 -	64 -	89 -
III. Oct. 1907/08 12 months	4,413,599	19 -	60 -	86 -
3 years	15,715,723	23 %	63 %	87 %
3 years	Our calculations (p. 85)	*m* 22 -	55 -	79 -
		w 26 -	68 -	95 -

As was to be expected, the summation values of MASTERMAN are higher than our *m* values calculated from the mixed series of measurements. But at the same time they are lower than our *w* values. This was also to be expected, as the correction has been introduced here with respect *to all* landings in all English ports, including London; MASTERMAN's values, on the other hand, refer only to the landings of Grimsby, the only port where measurements were made for the area A_3. The relatively larger quantities of small plaice are certainly landed in London, however, and chiefly from the areas A_3 and B_4, above all in the months of May and June, when, moreover, the average of the plaice in the landings from these areas is lower than in the other months. It is thus tolerably certain, that the relative number of small plaice would have been greater in MASTERMAN's calculations, had measurements also been made in London.

The differences in the composition of the monthly summation series, which are given uncorrected in Table 5, are not very great. The results in this Table are, however, owing to the incompleteness of the material, but little representative. It is probable, if we had sufficient measurements for January, when they are quite wanting, and

for the remaining winter months, that all the principal values of the summation series would be higher in winter than in spring and summer, as we shall find is exceedingly characteristic for B_4.

From the above discussion and Tables it appears, that *A_3 is an area of the North Sea from which, practically, almost all the plaice landed are "small"*. By weight these amount to over 80 %, by number to at least over 90 % of the total landings. The so-called *undersized* plaice — below 25 cm. — compose very probably over 50 % of the total quantity.

2. Area B_4. *20—40 m. South-eastern North Sea.* 6,300 square miles.

The English landings and measurements for this area during the period Oct. 1905/08 are as follows:

Area B_4 1905/98	large	medium	small	size not distinguished	Totals
	kg.	kg.	kg.	kg.	kg.
landed	431,089	2,426,411	9,330,410	84,912	12,272,822
%	3.51	19.77	76.03	0.69	100.00
	kg.	kg.	kg.	kg.	kg.
measured	7,743	34,151	74,819	2,889	119,601
%	6.47	28.53	62.54	2.46	100.00
	nos.	nos.	nos.	nos.	nos.
	5,498	107,487	454,091	16,617	583,693
%	0.94	18.42	77.79	2.85	100.00
	19.36		80.64		

Average weight of the plaice measured

	kg.	kg.	kg.	kg.	kg.
a. classes distinguished	1.426	0.318	0.165	0.174	
b. classes not distinguished, total	—	—	—	—	0.205

Estimated numbers of plaice landed calculated from landings in kg. / aver. of measured in kg.

a. classes distinguished	302,306	7,630,223	56,547,939	488,000	64,968,468
%	0.46	11.74	87.05	0.75	
	12,20		87,80		
				Average weight kg. 0,189	
b. classes not distinguished	—	—	—	—	59,867,527

The absolute quantity of plaice landed in English ports from area B_4 is almost double that from A_3 and is only exceeded by the quantities from C_2 and B_3. B_4 also is only fished by steam-trawlers; the catch per day of voyage, according to MASTERMAN (90), amounts to 294 kg. on an average for the three years and is thus considerably lower than for A_3 (492 kg.).

From the average weight of the plaice, 205 gm., calculated from all the measurements without distinction of classes, the total landings of 12,272,822 kg. mean a total number of 59,867,527 plaice. The probable number calculated from the average weights of the different market-classes is, on the other hand, 64,968,468. Thus, relatively too few small plaice have been measured; the small amount to only 62.54 % by weight in the measurements, but in the landings probably 76.03 %; by number, correspondingly, 77.79 % in the measurements, probably 87.05 % in the landings.

The unsorted measured have almost the same average weight (174 gm.) as the small (165 gm.), and may thus for practical purposes be regarded as small and combined with these. This gives in the measurements 19.36 % large + medium and 80.64 % small, in the landings probably 12.20 % large + medium and 87.80 % small,

Table 6. Area B_4. English Market-Measurements 1905/08.
Principal values of the summation curve.

Month	Extr.	D	Q	M C	Q	D	V	Extr.
November	18	21.90	23.87	26.08	28.50	30.81	32.41	64
December	18	22.61	24.54	26.73	28.99	31.32	32.83	71
January	20	23.46	25.83	28.78	33.00	41.59	47.79	69
February	18	22.12	25.06	28.81	33.45	42.96	50.46	71
March	17	21.33	22.77	24.82	27.93	32.00	34.58	68
April	19	22.01	23.61	25.88	28 66	31.48	33.22	69
May	17	21.52	22.82	24.93	27.91	30.68	32.24	58
June	18	22.48	23.93	26.00	29.00	31.76	33.46	60
July	20	22.38	24.00	26.17	28.95	31.83	33.33	47
August	19	22.54	24.20	26.57	29.44	32.23	34.13	57
September	19	22.07	23.62	26.03	29.17	31.62	33.93	44
October	16	22.09	23.41	25.15	26.93	28.91	30.38	45
3 years	16	*m* 22.09	23.73	25.92	28.69	31.59	33.71	71
		w	23.51	25.56	27.89			
average for 4 months (third of year).								
I. Spring	18	21.83	23.28	25.41	28.37	31.48	33.37	34
II. Summer	19	22.27	23.81	25.99	28.62	31.15	32.94	48
III. Winter	19	22.52	24.82	27.60	30.98	38.87	40.87	69

in round numbers 19—81 against 12—88. By means of these numbers we are able, just as in the case of A_3, to calculate approximately the corrections for the values derived from the measurement series in Appendix Table II.

The accompanying Table 6 gives the principal values of the summation curve for the different months and for the whole year as sum of the three years.

A graphic representation of this composition of the summation series is given in fig. B_4, Plate I. The measurement series are given in Appendix Table II.

The composition of the landings from B_4 resembles in general that for A_3, yet some noteworthy differences are present.

Firstly, the plaice in B_4 are somewhat larger than in A_3, as was to be expected, since B_4 is a deeper area and at the same time lies further from the coast. The length of the plaice is from 16—71 cm. and the principal values of the year curve are on the whole somewhat higher than in A_3.

We have the following percentages:

below	23	25	26	29	31	36 cm
m	18 %	40 %	51 %	77 %	88 %	98 %
w	20 -	43 -	55 -	84 -	92 -	99 -

All these summation values are lower than in A_3. The undersized plaice compose probably only 43 % against 55 % in A_3, the small plaice (below 29 cm.) only 84 % against 95 %.

For the sake of comparison the following data show the results from MASTERMAN's calculations (92):

B_4	Estimated total number of plaice landed	under		
		23 cm	26 cm	29 cm
I. 1905/06 Grimsby, 11 months	17,936,190	22 %	59 %	84 %
II. 1906/07 Grimsby, 12 months	19,108,087	15 -	51 -	82 -
Lowestoft, 2 months	175,501	24 -	71 -	89 -
Boston, 9 months	176,443	26 -	57 -	78 -
III. 1907/08 Grimsby, 12 months	12,810,743	13 -	47 -	78 -
Totals	50,206,964	18 %	53 %	82 %

The agreement between these results and our *w* values is very good, when it is remembered, that here, as in the case of A_3, our corrections refer to all landings, including London, whilst MASTERMAN's results are only concerned with the landings in the English ichthyometric ports. The correction in the median or central value means a reduction from 25.92 to 25.56; the lower quartile is reduced from 22.73 to 23.51; the upper quartile from 28.69 to 27.89 cm.

The differences in the composition of the landings in the various months are very noteworthy; in the case of A_3 these were little or not at all in evidence. Almost

without exception the principal values of the summation curve, e. g. median, are highest in the winter months, rising mostly from November to February. Then follows in March a sudden, quite unexpected fall, for example, in the case of the median, of 4 whole centimetres from 28.8 to 24.8. These low values persist during the 4 spring months from March to June, but in June already rise again somewhat and still more in the summer months of June and August. In September the values sink again and reach a second minimum in October.

Expressed in words, this means, that in the winter landings, especially those of January and February, the small plaice up to about 25 cm. in length decrease greatly in numbers by comparison with the other months of the year, whilst the larger plaice are relatively more numerous and the quite large plaice especially, which in summer are very scattered or only occur singly, are caught in some quantity. The numerous, small plaice, which are missed in the catches of winter, now appear in March quite suddenly and unexpectedly. Their relative number then remains the same during the spring months, but sinks somewhat in the summer months and once more rises in Septemper and October to a second maximum. The following comparison shows even more clearly this characteristic fluctuation in the quantities of small and large plaice.

In the landings from area B_4 we find the following, calculated from the Table of the measurements:

	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
below 26 cm...	49	37	26	31	60	51	60	46	50	44	50	63
over 45 cm....	0.1	0.6	6.2	8.0	2.0	0.2	0.04	0.3	0.0	0.2	0.0	0.0

The difference in composition between the winter and summer landings is thus in fact very great. The winter catches have quite a similar composition to the landings from the area C_2, that is, an area much deeper and further from the coast than B_4. To find an explanation of this remarkable occurrence, we may compare the scientific hauls of the research-steamers with the landings on the market. We then find, that the scientific hauls of the summer in area B_4 contain very large quantities of still smaller plaice from 11 to 16 cm., which are wanting in the landings, because they are picked out as worthless by the fishermen and thrown overboard. In the winter scientific hauls, on the other hand, these quite small plaice are practically wanting and the composition of these catches is quite similar to that of the landings. We have two possible explanations of the phenomenon. Firstly, the quite small plaice are not caught in winter in area B_4, simply because they are not there; if this were correct, then they must be somewhere else and thus at some other place even more numerous than in summer; but neither the landings nor the scientific hauls show any specially great accumulation of small plaice anywhere in winter. Secondly, the quite small plaice are lacking in winter, because the trawl does not catch them, though present. In this we have the only explanation remaining, namely, that the young plaice up to about 25 cm. in length *rest* for a great part during the winter, burying themselves in the ground, so

that the trawl passes over without taking any great quantities of them. *In March the winter rest is over,* the small plaice come into movement again in seeking their food and now suddenly reappear in great quantity in the hauls.

The percentage series for the large plaice (over 45 cm.) shows, further, that these are caught in the winther months not only relatively but also absolutely in great quantities, their numbers being greater than they should be by comparison with the relative decrease of the small plaice. This is also confirmed by the investigations of the research-steamers. It follows, therefore, that there must be an immigration of larger plaice into area B_4 from other areas in the winter months from December to February, that the number of these immigrants decreases from March onwards and that in summer they have practically disappeared from the area.

The second wave of small plaice in September and October may probably be explained as due to the larger plaice, which migrate out from B_4 in the course of the summer towards C_2, becoming replaced at the end of the summer by younger plaice forcing their way in from the shallower coastal waters, e. g. area A_3.

It may be objected to these conclusions, however, that they are based upon the uncorrected values of our series of measurements for the area B_4, thus on numbers affected by a considerable error, which, perhaps, if calculated on MASTERMAN's method, would not show these monthly differences. This objection breaks down, when we see, that MASTERMAN's calculations, so far as they can be used here, give quite the same differences in the monthly landings. This is shown by the following summary of the landings in Grimsby for the year 1907/08 from area B_4.

According to MASTERMAN (93) the percentages under certain lengths in the landings are as follows:

Landings in Grimsby 1907/08		Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
	cm												
% below	23	10	9	5	8	30	18	12	12	6	9	18	17
- »	26	45	38	27	28	54	50	48	50	33	39	49	57
- »	29	79	74	57	52	76	76	79	81	68	69	76	84

Thus, the differences from month to month and from four months to four months are seen just as clearly here as in our summaries.

The curves showing the composition of the landings in the different months, which are given in fig. 19 p. 79 and fig. 2 B_4 of Plate I, also display the above differences in the clearest possible manner. The course of the connecting lines between the monthly, principal values, which are parallel as a rule, changes remarkably at two places; firstly, in the period from December to March, where the lines bend strongly upwards or outwards and at the same time course at a distance from one another; secondly, in September to November when, conversely, the course of the lines becomes flattened and they thus come to lie much nearer to each other.

For the practical fishery we might well combine the two areas A_3 and B_4. Both are areas of the North Sea, at any rate, in which very large quantities of young,

undersized plaice are destroyed and which therefore have the greatest importance for the question of protective legislation.

3. Area B_3. *20—40 m. Southern North Sea.* 10,700 square miles — Spawning region.

This area B_3 is the largest in extent and the most important practically for the English plaice fishery in the southern North Sea.

The English landings and measurements during the period Oct. 1905/08 give the following results:

Area B_3 1905/08	large	medium	small	size not distinguished	Totals
	kg.	kg.	kg.	kg.	kg.
landed	4,639,462	4,777,486	8,676,945	2,439,924	20,533,817
%	22.59	23.27	42.26	11.88	100.00
	kg.	kg.	kg.	kg.	kg.
measured	88,956	57,756	179,595	97,879	424,186
%	20.98	13.61	42.35	23.06	100.00
	nos.	nos.	nos.	nos.	nos.
	239,441	184,750	1,183,921	604,123	2,212,235
%	10.82	8.35	53.52	27.31	100.00
	19.17		80.83		
Average weight of the plaice measured.					
	kg.	kg.	kg.	kg.	kg.
a. classes distinguished	0.372	0.313	1.152	0.162	
b. classes not distinguished, total	—	—	—	—	0.192
Estimated number of plaice landed.					
a. classes distinguished	12,471,672	15,263,533	57,085,164	15,061,259	99,881,628
%	12.49	15.28	57.15	15.08	100.00
	27.77		72.23	Average weight	kg. 0.206
b. classes not distinguished, total	—	—	—	—	106,946,963

The absolute quantity of plaice landed from B_3 in English ports is greater than that from any other area of the North Sea. This is a consequence, partly of the great extent of this area (10,700 square miles), partly of the considerable density of its plaice population, though this is considerably less than in area A_3 and somewhat less than in B_4. The catch of the steam-trawlers per day of voyage according to MASTERMAN (90) amounts to 263 kg. on an average for the three years. The English

plaice fishery in this area is carried on not only by steam-trawlers, however, as in A_3 and B_4, but also by sailing-trawlers and more especially by the latter, so that the product of the sailing-trawlers in greater than that of the steam-trawlers. The principal port for the sailing fishery in B_3 is Lowestoft. The total quantities of 20,533,817 kg. landed in 1905/08 divided by the average weight per plaice of 192 gm., which is obtained from the measurements, gives a total number of 106,946,963 plaice. The probable number calculated from the average weight of the market-classes separately is 99,881,628.

Appendix Table III gives the analysis of the market-measurements from B_3 as the sum for the three years. All the months of these three years are well represented and the material is thus complete.

Table 7. Area B_3. English Market-Measurements 1905/08.
Principal values of the summation curves.

Month	Ext.	D	Q	M C	Q	D	V	Ext.
November	17	22.00	23.73	25.67	28.60	32.10	35.00	68
December	18	22.14	23.84	25.97	29.59	34.20	39.00	71
January	18	22.44	24.35	27.42	31.67	36.50	41.00	71
February	17	20.92	22.62	25.53	30.29	36.86	42.57	68
March	17	21.12	22.75	24.90	27.70	31.36	34.20	70
April	15	21.24	23.10	24.90	28.08	31.56	34.28	66
May	16	21.35	23.05	25.40	28.46	31.56	33.00	64
June	17	21.27	22.97	24.39	28.54	31.56	33.30	59
July	17	21·60	23.56	26.25	30.06	33.06	36.30	61
August	18	21.80	23.50	26.18	28.85	31.00	34.16	60
September	18	22.12	23.70	25.90	29.03	32.23	34.70	63
October	17	21.97	23.54	25.61	28.43	31.37	33.40	62
3 years	15	*m* 21.52	23.26	25.58	28.82	32.57	35.21	71
		w	23.69	26.02	30.43			
Averages for 4 months (third of the year).								
I. Spring	17	21.24	22.97	24.90	28.19	31.51	33.69	65
II. Summer	16	21.87	23.58	26.01	29.09	31.91	34.64	62
III. Winter	17	21.87	23.63	26.15	30.04	34.91	39.39	70

The graphic method of representing this summation series is shown in fig. 3 B_3 of Plate I.

The representative value of these analyses is fairly great. From the summary of the landings and measurements it appears, that the classes unsorted and small

have almost the same average weight and further, that the classes large and medium are not very different in average weight. We may thus construct two groups, large + medium and small + unsorted. In the measurements the relative numbers of these two groups are as 19 to 81, in the landings as 28 to 72. The difference is not very great; yet it will be seen, that somewhat too many small and unsorted have probably been measured, with the result that the estimated total number of about 107 millions is greater than the probable number of about 100 millions. By means of the proportions 19 : 81 and 28 : 72 we are able to obtain the probable summation-values of the series from those arrived at from the measurements.

We have:

below		23	25	26	29	31	36 cm
B_3	*m*	22 %	44 %	54 %	76 %	85 %	96 %
	w	20 -	39 -	48 -	68 -	78 -	94 -
B_4	*m*	18 -	40 -	51 -	77 -	88 -	98 -
	w	20 -	43 -	55 -	84 -	92 -	99 -

The median or central value moves from 25.85 to 26.02 cm. when corrected; the lower and upper quartiles from 23.26 to 23.69 and from 28.82 to 30.43 respectively.

MASTERMAN's calculations (94) give the following results for the landings from Grimsby, Lowestoft and Boston:

B_3	Estimated total number of plaice landed	below		
		23 cm.	26 cm.	29 cm.
		%	%	%
I. 1905/06 12 months . .	21,502,539	26	52	72
II. 1906/07 12 months . .	37,073,644	21	53	76
III. 1907/08 12 months . .	39,619,156	20	56	79
3 years	98,195,339	22	54	76

It will be seen, that these summary values of MASTERMAN for the three ichthyometric ports agree exactly with our *m* values calculated from the series of mixed measurements. This would indicate, that these *m* values for B_3 have a very high, representative value. Our *w* values adjusted to the total number of landings from all ports are not a little lower than those given by MASTERMAN; the difference might be taken to indicate, that the total landings from B_3 in all ports contain relatively fewer small plaice than the landings of the ports Grimsby, Lowestoft and Boston. This does not seem at all likely, as the next important port, London, would rather lead us to expect an increase of the small plaice. The difference remains therefore somewhat obscure.

If we compare the composition of the landings from B_3 with that of the landings from B_4, we find a very considerable resemblance between the two areas. But in B_3

the plaice are on an average somewhat larger than in B_4. The quantity of undersized plaice (below 25 cm.) is somewhat lower in B_3 than in B_4, 39 % against 43 %, that of the small plaice (below 29 cm.) likewise lower, 68 % against 84 %. The number of large plaice (over 35 cm.) amounts probably to only 1 % in B_4, probably to 6 % in B_3.

The great resemblance between the areas B_3 and B_4 is also seen in the fact, that the composition of the monthly catches in B_3 shows the same, characteristic fluctuations as in B_4. Table 7 and the summary below make it evident, that the principal values of the summation curve also attain their maximum here in the winter, and suddenly decrease greatly in March and April. A second, smaller minimum occurs from September to November.

Area B_3	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
below 25 cm.	54	50	31	46	52	60	56	46	38	41	51	55
above 35 -	4	6	10	11	4	3.5	2.5	2	5	3	4	2.5

The results of MASTERMAN's calculations are the same.

Thus, in B_3 there must also be a period of winter-rest for the small, immature plaice. The graphic method, fig. 3 B_3 Plate I, also shows the swelling in the course of the lines in winter.

4. Area C_3. *40—60 m. Southern North Sea.* 1,800 square miles. Principal spawning-region.

The English landings and measurements from this area during the period October 1905/08 are shown in the following Table.

Areas C_3 1905/08	large	medium	small	size not distinguished	Totals
	kg	kg	kg	kg	kg
landed	3,364,383	843,228	1,996,948	254,914	6,459,473
%	52.08	13.05	30.92	3.95	100.00
	kg	kg	kg	kg	kg
measured	54,422	3,129	31,487	30,269	119,307
%	45.60	2,61	26.40	25.39	100.00
	nos	nos	nos	nos	nos
	152,777	12,101	228,904	121,216	514,998
%	29.72	2.34	44.48	23.46	100.08

Average weight of the plaice measured.

	kg	kg	kg	kg	kg
a. classes distinguished	0.356	0.259	0.138	0.250	
b. classes not distinguished	—	—	—	—	0.232

Estimated total number of plaice landed.

Areas C_3 1905/08	large	medium	small	size not distinguished	Totals
a. classes distinguished . . .	9,450,514	3,255,707	14,470,638	1,019,653	28,196,515
%	33.52	11.55	51.32	3.62	100.00
			Average weight kg. 0.229.		
b. classes not distinguished .	—	—	—	—	27,842,556

The area C_3 is, in extent, the smallest subdivision of the southern North Sea (1,800 square miles); by comparison with its small size, however, it is one of the richest plaice grounds of the North Sea, perhaps the richest in marketable plaice. MASTERMAN estimates the catch of the steam-trawlers per day of voyage to be 287 kg. (90), that is, just as great as in B_4. Here, however, it is different from the other areas; the plaice fishery is not mainly carried on by steam-trawlers, but much more and predominantly by sailing-trawlers, chiefly from Lowestoft. During the period 1905/08 the sailing-vessels caught nine times the quantity by weight of the steam-trawlers. A very remarkable characteristic of this area is, further, that by far the largest quantities of plaice are caught, not in the summer as in the areas discussed so far, but in the *winter;* more than half of the total landings, for example, are concentrated in the months from December to February (95). The total quantity of plaice landed in 1905/08, 6,459,473 kg., divided by the average weight per plaice calculated from the measurements, 232 gm., gives a total number of 27,842,556 plaice; from the market-classes taken separately the probable number is 28,196,515.

Table 8. Area C_3. English Market-Measurements 1905/08.
Principal values of the summation curves.

Month	Ext.	D	Q	M C	Q	D	V	Extr.
November	19	23.40	24.80	27.17	30.60	34 54	37.40	63
December	18	21.87	23.91	26.84	31.45	35.85	40.00	66
January	17	22.15	24.20	27.05	32.03	36.34	39.60	69
February	18	22.43	25.43	27.73	32.80	37.00	40.00	69
March	17	22.11	24.00	26.63	31.50	36.10	39.00	67
April	18	21.23	22,64	24.59	27.28	31.27	34 36	51
May	18	21.20	22.20	24.90	27.58	31 00	33 00	50
June	18	22.28	24.00	26.90	31.19	35.60	39.00	62

Month	Extr.	D	Q	M C	Q	D	V	Extr.
July	17	21.80	24.05	27.04	30.57	34.00	36.50	50
August	17	23.13	25.57	28.50	31.67	34.70	37.00	67
September	18	22.80	24.74	27.67	30.84	34.30	36.00	61
October	18	23.00	24.60	27.10	30.10	33.30	35.40	56
3 years	17	22.26	24.21	*m* 27.12 *w* 26.20	31.31	35.37	38.31	69
average for 4 months (third of year).								
I. Spring	18	21.71	23.21	25.75	29.39	33.49	36.34	58
II. Summer	18	22.48	24.74	27.58	30.79	34.08	36.22	58
III. Winter	18	22.46	24.58	27.20	31.72	35.93	39.25	67

The representation of these principal values graphically is given in Fig. 4 C_3 Plate I.

The representative value of the analyses of the market-measurements given in Appendix Table IV must be considered very good. The average weight of the class "unsorted" is almost exactly equal to that of the "medium". Combining the classes "large", "medium" and "unsorted" and contrasting this group with the "small", we obtain two groups in which landings and measurements are in good agreement both by weight and number. The "small" amount to 44 % by number in the measurements, and probably 51 % in the landings; the other group correspondingly 56 % and 49 %. By means of these numbers the probable summation values may be calculated from the measured series.

We have the following percentages for the different sizes:

below		23	25	26	29	31	36 cm.
C_3	*m*	15 %	32 %	41 %	62 %	73 %	92 %
	w	17 -	37 -	48 -	67 -	77 -	93 -
B_3	*m*	22 -	44 -	54 -	76 -	85 -	96 -
	w	20 -	39 -	48 -	68 -	78 -	94 -

The median or central value for the year's series for C_3 is reduced from 27.12 to 26.20 when corrected.

MASTERMAN's results (96) for these landings in Lowestoft and Boston are as follows:

C_3	Estimated total number of plaice landed	below 23 cm.	below 26 cm.	below 29 cm.
I. 1905/06	6,546,407	12 %	33 %	54 %
II. 1906/07	7,200,219	19 -	46 -	66 -
III. 1607/08	7,176,552	16 -	47 -	69 -
3 years	20,923,178	16 %	42 %	63 %

Thus in C_3, as in B_3, the results obtained by MASTERMAN agree with our *m* values calculated from the mixed series of measurements, and indicate therefore, that the latter possess a high representative value as samples of the landings in the ichthyometric ports. Our correction for the landings of all ports gives somewhat higher values. The 7 million plaice, by which approximately our estimate exceeds that of MASTERMAN (21 millions), must therefore contain relatively more small plaice.

The composition of the landings from C_3 thus shows a very good agreement with those from B_3. But the average size in C_3 is probably somewhat higher than in B_3. The percentage of undersized plaice in C_3 is 37, of the "small" plaice 67.

The very marked *difference between winter and spring months,* which we found in the landings from B_4 and B_3, is also apparent in the case of C_3, but in another form. This can be seen in the 4-monthly averages in Table 8 and also in the series below:

	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
	%	%	%	%	%	%	%	%	%	%	%	%
below 25 cm. .	27	35	34	30	35	56	51	35	33	21	27	28
over 35 cm. .	7.0	8.5	11	13	10	2.5	2.2	9.3	4.5	6.5	6.2	4.1
over 45 cm. .	0.6	1.2	1.4	1.2	0.9	0.2	0.2	1.1	0.3	0.6	0.9	0.3

It will be seen from this, that very large quantities of plaice below 25 cm. (over 50 %) occur in the months of April and May and at the same time very few larger, only about 2 % over 35 cm. and 0.2 % over 45 cm. In the remaining months the amount of small plaice below a length of 25 cm. is on the other hand only 21 to 35 %, that of the larger over 35 cm. 4.1 to 13 %, that of the large over 45 cm. 0.3 to 1.4 %. In the true winter months, December to March, there is a distinct *maximum of the large and largest plaice* (8.5 to 13 % and 0.9 to 1.4 % respectively), but, curiously enough, not a corresponding minimum for the small plaice below 25 cm. These, though considerably fewer than in April and May, are yet relatively more numerous than in the months of July to November.

The results of MASTERMAN's calculation for C_3 for the different months, so far as they are comparable, agree with ours.

The strikingly high numbers of the larger and large plaice in the months December to February would certainly be very much higher, if we change from the relative to the absolute numbers. As remarked above, very much larger quantities of plaice are landed from C_3 during the winter months mentioned than in a corresponding number of summer months. For example, in the year 1906/07 approximately six times as many plaice by weight were landed from C_3 in the months of January and February as in the two months of April and May. If, therefore, the percentage of larger plaice over 35 cm. in our measurement samples is five times as great in January and February as in April and May, then the absolute numbers in the landings may be considered as still greater, possibly as much as 30 times greater. That this great accumulation of larger plaice in the winter hauls in area C_3 by comparison with the spring and summer hauls, implies a corresponding accumulation of the plaice stock there, can certainly not be taken for granted, but yet may be considered as to some extent very probable. This

means, that the large plaice over 35 cm., i. e. mostly the mature females, collect together in the area C_3 at the *spawning-time* in considerable quantities, gravitating there probably in the course of the autumn from other areas. At the end of the spawning-period, probably in March, the spawned plaice again leave this spawning-area. Add to this, that the mature males, at least the larger from about 25 to 35 cm., probably take part also in this inward and outward migration (with reference to C_3), then we have in this at least a partial explanation of the great decrease in the principal values of the summation curve in April, without it being necessary here, as in the case of B_4, to assume a long period of winter rest for large quantities of the small plaice, though this may also occur here to a small extent. The correctness or otherwise of this hypothesis may be left for future investigations to determine. It is certain, that the special features in the product of the fishery in C_3 in the winter, the large catches by comparison with the smallness of the area and the composition of the landings, are in striking agreement with the fact, determined in another way, that spawning takes place here on a large scale in the winter months, when also the pelagic eggs of the plaice occur in greater density than in any other subdivision of the North Sea.

5. **Area B_2.** *20—40 m. Southern North Sea.* 5,900 square miles.

The English landings and measurements from this area during the period 1905/08 were as follows:

Area B_2 1905/08	large	medium	small	unsorted	Total
	kg.	kg.	kg.	kg.	kg.
landed	3,458,515	3,676,244	2,644,039	60,096	9,838,894
%	35.15	37.37	26.87	0,61	100.00
	kg.	kg.	kg.	kg.	kg.
measured	22,142	24,956	40,586	5,298	92,982
%	23.76	26.88	43.66	5.70	100.00
	nos.	nos.	nos.	nos.	nos.
	47,449	102,769	212,452	18,785	381,455
%	12.42	26.95	55.70	4.93	100.00
Average weight of the plaice measured.					
	kg.	kg.	kg.	kg.	kg.
a. classes distinguished	0.467	0.243	0.191	0.282	—
b. total	—	—	—	—	0.244
Estimated total number of plaice landed.					
a. classes distinguished	7,404,957	15,128,576	13,843,136	213,106	36,589,775
%	20.24	41.35	37.83	0.58	100.00
	Average weight kg. 0.269				
b. classes not distinguished	—	—	—	—	40,323,336

As regards absolute quantity of plaice landed, the area B_2 occupies fourth place coming behind only B_3, C_2 and B_4. About two-thirds of the landings are taken by steam-trawlers, one-third by sailing-trawlers (mostly from Lowestoft). The catch per day of voyage of the steam-trawlers is given by MASTERMAN (90) as 164 kg., thus considerably less than in the areas hitherto dealt with and about half of the catch in B_4. The total quantity of plaice landed in 1905/08, 9,838,894 kg., corresponds to the number of 40,323,336 plaice, the average weight per plaice calculated from the measurements being 244 gm.; the calculation from the market-classes taken separately gives 36,589,775.

The representative value of the analyses given in Appendix Table V is obviously not very great; considerably too many small plaice have been measured. In endeavouring to correct the m values, calculated from the measurement series, we meet with the following difficulty. We see from the average weights of the plaice measured, that the classes "medium" and "unsorted" have approximately the same weight and may thus be combined. We thus have the classes large, medium + others, small, which stand in the relation by number 12.42 : 31.88 : 55.70 according to the measurements and 20.24 : 41.93 : 37.83 in the landings. If we arrange these plaice in only two groups for the purpose of correction, we may be in doubt as to whether the large or the small should be taken as the one group and contrasted with the other two as the other group. If we take the large we have 12 : 88 % in the measurements against 20 : 80 % in the landings; if we take the small, we have 44 : 56 % against 62 : 38 %. Using these proportions to correct the m values, we obtain a different result in the two cases; in the former the correction coefficient is 80 : 88, in the latter 38 : 56. Since the average weights of the medium and others (243 and 282 gm.) come nearer to that of the small than to the large, we may assume, that the correction by means of 80 : 88 (thus, large contrasted with medium + others + small) will give the better results. The values obtained in this way may be called w_1, those in the other way w_2.

The composition of the landings from B_2 would thus be:

below	23 cm.	25 cm.	26 cm.	29 cm.	31 cm.	36 cm.
B_2 m	10 %	26 %	35 %	60 %	73 %	92 %
w_1	9 -	24 -	32 -	55 -	66 -	87 -
w_2	7 -	18 -	24 -	44 -	50 -	89 -
average of w_1 and w_2	8 %	21 %	28 %	50 %	58 %	88 %
C_3 w	17 -	37 -	48 -	67 -	77 -	93 -
B_3 w	20 -	39 -	48 -	68 -	78 -	94 -
B_4 w	20 -	43 -	55 -	84 -	92 -	99 -

The results of MASTERMAN's calculations (97) are as follows for the landings of the ports Grimsby, Lowestoft and Boston:

Area B_2	Estimated total number of plaice landed	below		
		23 cm.	26 cm.	29 cm.
I. 1905/06	11,157,107	10 %	28 %	48 %
II. 1906/07	9,811,447	8 -	28 -	51 -
III. 1907/08	10,378,227	8 -	29 -	51 -
3 years	31,346,781	9 -	28 -	50 -
weight	9,206,379	average weight 0.294 kg.		

Thus, the values obtained by MASTERMAN lie between our corrected w_1 and w_2 values. As the w_1 values are the most probable, these would be somewhat higher than MASTERMAN's results; this indicates, that relatively somewhat more small plaice are contained in the landings of *all* ports from B_2 than in the landings of the ichthyometric ports alone. It must be remembered, however, in connection with these and other differences elsewhere between MASTERMAN's calculations and mine, that both methods have their errors and especially, that our correction-method only gives approximate values.

Comparing B_2 with the areas dealt with previously, C_3, B_3 and B_4, we recognize at once the great difference; the plaice of B_2 are considerably larger. Whilst the undersized plaice (below 25 cm.) still amount to about 40 % of the total number in the landings from the three areas mentioned, here in B_2 the percentage is only about 20; the small plaice (below 29 cm.) in the former amount to 70 to 80 %, but in the latter only to about 50 %.

Table 9. Area B_2. English Market-Measurements 1905/08.
Principal values of the summation curve.

Month	Extr.	D	Q	M (C)	Q	D	V	Extr.
November	18	23.02	24.70	27.17	31.02	35.27	38.63	62
December	20	24.68	26.57	29.47	33.45	36.95	39.70	67
January	20	24.74	26.97	30.04	33.12	36.03	38.53	67
February	19	24.01	26.00	28.71	32.18	36.44	42.90	66
March	18	22.74	24.88	27.55	30.60	34.13	37.83	64
April	18	22.38	24.21	27.06	30.93	34.90	37.89	67
May	18	22.30	24.57	27.11	30.03	33.58	37.07	61
June	18	23.06	25.11	27.21	31.95	35.68	37.01	59

Month	Extr.	D	Q	M (C)	Q	D	V	Extr.
July	17	23.01	25.45	28.74	32.33	33.54	38.02	65
August	18	23.31	25.20	27.88	31.04	34.00	36.06	59
September	18	22.67	24.16	26.35	29.74	33.42	36.47	64
October	19	22.62	24.22	26.21	29.44	33.43	35.61	65
3 years	17	22.97	24.89	*m* 27.70 *w* 28.33	31.27	34.88	37.73	67
Average for 4 months.								
I. Spring	18	22.62	24.69	27.23	30.88	34.55	37.45	63
II. Summer	18	22.90	24.76	27.29	30.64	34.10	36.54	63
III. Winter	19	24.11	26.06	28.85	32.44	36.17	39.94	65

The graphic representation of these values is shown in fig. 5 B_2 Plate I.

The difference in composition between the winter, spring and summer months can also be seen distinctly in area B_2, both in MASTERMAN's and in my calculations. Here also there is a maximum for the principal values in winter and two separate minima in spring and autumn. The contrasts and transitions between the different months are, however, not so steep and abrupt as in B_4, but more as in B_3; the course of the lines in the graphic representation is thus more regular than in B_4.

We have the following percentages in the different months:

Area B_2	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
	%	%	%	%	%	%	%	%	%	%	%	%
below 25 cm.	28	20	11	17	26	32	29	24	22	23	36	34
above 35 cm.	9	13	9	9	5	7	5	8	9	5	4	5

In contrast to the area C_3 the largest quantities of plaice are not taken in the winter months in B_2, but in summer as in B_4. The differences in the different months can scarcely be referred, therefore, to an accumulation of large plaice in winter for the purpose of spawning — plaice eggs have hitherto only been taken in small quantities in B_2 — but, as in B_4, to the hibernation of small plaice and their revival in spring on the one hand and, on the other, to the incoming stream of small plaice from the coast in September and October.

6. **Area C_2.** *40—60 m. Middle Eastern North Sea.* 11,700 square miles.

The English landings and measurements for this area during the period 1905/08 are summarised in the following Table.

Area C_2 1905/08	large	medium	small	unsorted	Total
	kg.	kg.	kg.	kg.	kg.
landed	5,552,643	5,817,058	4,493,411	2,382,115	18,245,227
%	30.44	31.88	24.63	13.05	100.00
	kg.	kg.	kg.	kg.	kg.
measured	89,096	73,642	122,462	4,093	289,293
%	30.82	25.45	42.34	1.41	100.00
	nos.	nos.	nos.	nos.	nos.
	83,696	166,950	523,521	21,287	795,454
%	10.70	20.90	65.80	2.60	100.00
	32.60		68.40		

Average weight of the plaice measured.

	kg.	kg.	kg.	kg.	kg.
a. classes distinguished	1.065	0.441	0.234	0.195	—
b. total	—	—	—	—	0.364

Estimated total number of plaice landed.

a. classes distinguished	5,213,749	13,190,608	19,202,611	12,406,849	50,013,817
%	10.42	26.36	38.36	24.86	100.00
	36.78		63.22		
				Average weight kg. 0.365	
b. classes not distinguished					50,124,250

The area C_2 is, in extent, the largest subdivision of the North Sea and certainly embraces very different fishing-grounds. The landings from this area come second in quantity, being only exceeded by those from the area B_3. As the latter is considerably smaller in extent than C_2, the density of plaice in C_2 must be very much smaller than in B_3. MASTERMAN (90) calculates the catch per day of voyage of steam-trawlers for the period 1905/08 to be 116 kg., against 263 for B_3 and 164 for B_4. The fishing here is carried on almost exclusively by steam-trawlers, that of the sailing-vessels being quite unimportant. The best months of fishing are August to November.

The total quantity of plaice landed during 1905/08 amounted to 18,245,227 kg.; the average weight per plaice calculated from the measurements was 364 gm.; this gives a total number of approximately 50,124,250 plaice. Taking the market classes separately the probable number is 50,013,817.

The representative value of the analyses given in Appendix Table VI seems at first sight unsatisfactory, as obviously too many "small" plaice by number and weight have been measured. Nevertheless, there is the remarkable fact, that the unsorted plaice measured have a lower average weight than the "small", and may be taken therefore practically as small. As no less than 13 % of the landings are unsorted and as the calculation of the number of these is made by means of the lower average weight of 192 gm., it follows, that the relative quantity of the small + unsorted is greatly increased in the calculated total number of the landings. Of this group the measurements contain 68 %, the landings 63 %, thus a good agreement. This becomes even greater, when, as seems necessary owing to the great difference between the average weight of the large and of the medium, we construct the two groups large and medium + small + others. In this case we have 11 : 89 % in the measurements contrasted with 10 : 90 % in the landings, that is, complete agreement. We may call the probable values obtained by the correction 68 : 63 w_1, those by 89 : 90 w_2. Corresponding to this great agreement we also have the approximately equal total numbers calculated from the measurement series and from the different classes separately, as also their equal average weights of 364 and 365 gm.

We have the following summation values:

below	23 cm.	25 cm.	26 cm.	29 cm.	31 cm.	36 cm.
C_2 m	6 %	16 %	22 %	44 %	58 %	81 %
w_1	6 -	16 -	22 -	44 -	58 -	81 -
w_2	6 -	15 -	20 -	41 -	54 -	78 -
B_2 m	10 -	26 -	35 -	60 -	73 -	92 -
w_1	9 -	24 -	32 -	75 -	66 -	87 -

MASTERMAN's calculations (98) for the landings in the three ichthyometric ports give the following results:

Area C_2	Estimated total number of plaice landed	below 23 cm.	below 26 cm.	below 29 cm.
I. 1905/06	12,200,393	7 %	35 %	49 %
II. 1906/07	11,819,813	7 -	27 -	53 -
III. 1907/08	18,540,134	7 -	30 -	59 -
3 years	42,560,340	6 -	31 -	54 -
Weight in kg.	13,067,229			
Average weight 0.307 kg.				

It will be seen, that MASTERMAN's results agree very badly with ours, even with the uncorrected m values, to which they come nearest though still very far removed,

owing to the larger number of small plaice. This great difference is very striking and is difficult to explain even if we assume, that the large, relative surplus of larger plaice, which is present in our mixed series, was derived solely from the approximately $7^1/_2$ million plaice by which the estimated total number of the landings of all ports exceeds those of the three ichthyometric ports. I imagine, that the cause lies in a different direction. From the summary given above for C_2, it will be seen, that very large quantities of the class "size not distinguished" were landed (over 2 million kg.), but very few were measured, only 21,287 with a weight of 4,093 kg. (99). These few unsorted, further, were all measured in one year (1905/06) and mostly in Lowestoft. Their average weight is remarkably low (191 gm.). It seems extremely doubtful, if this one small sample measured in the year 1905/06 can be taken as representative of the large quantities of unsorted plaice landed in all three years; it is much more probable, that the true average weight of all the unsorted plaice landed from C_2 was greater than 191 gm. and, consequently, that the total number of these calculated by us here (12,406,749) is too great.

This, possibly low, representative value of the sample of "unsorted" plaice measured makes not only our calculations uncertain but also MASTERMAN's. It cannot be seen, certainly, from his Report, how he has dealt with each sample of the "unsorted" — the composition of the market-classes landed from the various areas in the different ports and months is unfortunately almost never indicated in his Report — but as no other samples of these unsorted plaice from C_2 were at his disposal in the three years, he must have made use of them in some way. It seems to me probable, that he has calculated too many small plaice for the class "size not distinguished" and thus also for the whole area C_2. In our case we can find a way out of the difficulty by taking together the landings as well as the measurements of all medium, small and size not distinguished and contrast these as one group with the large. The average weight of the group large amounts to 1065 gm., that of the combined other group 281 gm. By means of these numbers we obtain as probable total number of the second, combined group 45,169,336, altogether 50,013,817 plaice, or 10 % : 90 %, that is, almost precisely the same result as before. This result used to correct our m values gives the values w_1, which indeed are identical with the first. Consequently, our mixed series of measurements may be regarded as fairly representative of the total landings in all ports. In this case, therefore, it is very probable, that my procedure of constructing the mixed series of measurements gives a better result than MASTERMAN's method. The more exact method followed by MASTERMAN will give unsatisfactory values, indeed, when the composition of the samples used for his calculations is not representative for the market-class concerned, and this will occur most readily in the case of the unsorted plaice.

According to MASTERMAN's calculations, therefore, there are relatively more small plaice in the landings from C_2 than result from our investigations; correspondingly, the average weight given by him (307 gm.) is smaller by a considerable amount than ours (364 gm.).

If we compare the Area C_2 with B_2, our method gives a considerably higher average weight for the former (364 gm.) than for the latter (269 gm,) and, correspondingly, a relatively smaller number of small plaice in C_2 than in B_2. According to MASTERMAN the characteristics of the two areas are essentially different. Thus:

	below 23 cm.	26 cm.	29 cm.	average weight
in B_2	9 %	28 %	50 %	gm. 0.294
in C_2	6 %	31 %	54 %	— 0.307

Here the two areas are much more alike; perhaps even B_2 has relatively still fewer small plaice than C_2. Nevertheless, as mentioned, the probability is, that our result is correct so far as the total landings from all ports are concerned and in favour of this conclusion we also have analogies from the general distribution of the plaice.

According to this result, the "undersized" plaice in C_2 only amount to about 16 %, the "small" plaice to about 44 % of the total quantity, the large plaice over 35 cm. about 20 %.

Table 10. Area C_2. English Market-Measurements 1905/07.
Principal values of the summation curves.

Months	Extr.	D	Q	M (C)	Q	D	V	Extr.
November	19	25.00	27.46	31.76	39.90	47.94	51.07	71
December	18	24.13	26.15	29.10	33.53	43.77	47.83	70
January	18	24.57	26.66	29.42	33.05	41.41	47.74	70
February	19	23.98	26.38	29.56	34.37	44.12	49.00	69
March	19	23.66	26.00	29.03	34.18	43.42	47.66	70
April	19	23.80	26.42	29.80	33.27	39.00	44.27	68
May	18	24.13	27.09	30.84	34.21	39.68	44.16	69
June	18	23.00	25.35	29.09	32.81	37.67	42.07	63
July	17	23.21	25.62	29.11	33.02	37.36	40.84	64
August	19	24.50	27.27	30.84	34.72	39.45	44.74	70
September	19	24.00	26.07	29.67	34.18	39.47	44.00	70
October	20	24.78	27.74	31.20	38.28	45.61	49.00	70
3 years	17	24.00	26.38	*m* 29.73 *w* 29.73	34.03	40.35	44.94	71
Averages for 4 months.								
I. Spring	18	23.65	26.21	29.69	33.62	39.94	45.04	68
II. Summer	19	24.12	26.67	30.21	35.05	40.47	44.64	69
III. Winter	18	24.42	26.66	29.96	35.21	44.31	48.91	70

The graphic representation of these values is given in fig. 6 C_2 Plate I.

The characteristic fluctuations in the composition of the landings according to the season of the year are also apparent in C_2, but in a distinctly weaker and altered form. This can be seen from Table 10 and the following summary for the different months.

Area C_2	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
	%	%	%	%	%	%	%	%	%	%	%	%
below 25 cm.	10	16	12	16	17	17	14	22	21	12	17	12
above 35 cm.	31	18	15	19	20	13	16	12	12	18	17	29

In the half-year October—March there are more large (over 35 cm.) and fewer small (below 25 cm.) plaice than in the half-year April—September. There is no sign, however, of a sudden appearance of large quantities of small plaice and great diminution of the large in March and April, from which we were able to conclude the existence of a period of hibernation for the small plaice in the other areas lying nearer the coast. Further, the minimum for the small and the maximum for the large plaice do not lie here in the months of January and February, as in B_4, but in October and November; this is probably due, however, to the fact, that just in these months by far the greater part of the plaice measured came from Boston, where relatively many more large than small plaice were measured. Possibly therefore the maximum is only apparent. On the other hand, more Grimsby than Boston plaice have been measured in the summer months, which means perhaps, that the minimum of the large plaice in these months and the maximum of the small is apparent only. I am of opinion, therefore, that the numbers given here are not representative and that the hibernation of the small plaice is no longer of any importance in area C_2. This was to be expected also, for the small plaice, which are chiefly concerned in the question of hibernation, only occur in this area in small numbers on the whole. Of the seasonal fluctuations there is probably only the one in reality, namely, that in the winter half-year relatively somewhat more large plaice are present in the landings than in the summer months. This is possibly connected with the fact, that the area C_2 is a spawning-region — though not to the same extent as C_3 — at least in its southern parts bordering on B_4.

C_2 is the first of the areas so far dealt with in which a *selection of the catches for the market now hardly occurs;* with but few exceptions all the plaice caught are marketable. Here, therefore, the market-samples are identical with the catch-samples and may at the same time be regarded as stock-samples. The analyses of the scientific hauls with the trawl in C_2 show, that practically no plaice below 15 cm. and only few below 18 cm. are caught there.

7. **Area C_1.** *40—60 m. Western North Sea.* 5,700 square miles.

The English landings and measurements from this area during the period Oct. 1905/08 are shown in the following Table.

Area C_1 1905/08	large	medium	small	unsorted	Total
	kg.	kg.	kg.	kg.	kg.
landed	1,662,581	1,067,664	276,049	1,625	3,007,919
%	55.27	35.50	9.18	0.05	100.00

Area C1 1905/08	large	medium	small	unsorted	Total
	kg.	kg.	kg.	kg.	kg.
measured	12,953	13,309	6,157	—	32,419
%	40.00	41.00	19.00	—	100.00
	nos.	nos.	nos.	nos.	nos.
	11,309	36,092	29,723	—	77,124
%	14.66	46.80	38.54	—	100.00
		85.34			
Average weight of the plaice measured.					
	kg.	kg.	kg.	kg.	kg.
a. classes distinguished	1.145	0.369	0.207	—	—
b. total	—	—	—	—	0.420
Estimated total number of plaice landed.					
a. classes distinguished	1,452,036	2,893,400	1,333,570	—	5,679,006 (without unsorted)
%	25.57	50.94	23.49	—	100.00
		74.43			
			Average weight kg. 0.529		
b. classes not distinguished	—	—	—	—	7,161,712 (with unsorted)

This area, consisting of three separate parts off the east coast of England and Scotland (off Flamborough, Firth of Forth and Moray Firth), is almost exclusively fished by steam-trawlers and does not yield any very great quantities on the whole, nor of the medium and large. The catch per day of voyage of steam-trawlers is estimated by MASTERMAN to be 90 kg. (90). The density of the marketable plaice here is thus considerably smaller than in other C areas. In its whole character the area bears a strong resemblance to the Dogger Bank and the deep, northern subdivisions of the North Sea (D and E).

The total quantity of plaice landed during 1905/08 amounted to 3,007,919 kg.; the average weight calculated from the measurements, without regard for the market-classes, was 420 kg.; the total number of plaice was thus 7,161,712, but taking the market-classes separately the probable number is 5,679,006. The representative value of the analyses of the market-measurements given in Appendix Table VII is greatly influenced by the fact, that too many small plaice have been measured, namely 39 % against 23 % in the landings; or too few large, namely 15 % against 26 % in the

landings. According as we form the groups large and medium + small or large + medium and small, we obtain two different corrections; the first (w_1) and probably the better with 85 : 74, the second (w_2) with 39 : 23. We then have the following values of the summation curve:

below	23 cm.	25 cm.	26 cm.	29 cm.	31 cm.	36 cm.
C_1 m	2 %	7 %	12 %	34 %	49 %	78 %
w_1	2 %	6 %	10 %	30 %	43 %	68 %
w_2	1 %	4 %	7 %	20 %	36 %	72 %
C_2 m (w_1) . . .	6 %	16 %	22 %	44 %	58 %	81 %

MASTERMAN's results (100) for the ichthyometric ports Grimsby and Boston are as follows:

Area C_1	Estimated total number of plaice landed	below		
		23 cm.	26 cm.	29 cm.
I. 1905/06	521,921	0.2 %	4 %	15 %
II. 1907/07	2,026,636	0.9 %	8 %	24 %
III. 1607/08	2,221,656	1 %	8 %	22 %
3 years	4,770,213	0,9 %	8 %	22 %
Weight in kg.	2,444,291			

Average weight 0.512

It will be seen, that MASTERMAN's results agree well with our corrected w_2 values. The more probable values w_1 lead to the conclusion, that relatively more small plaice were contained in the total landings of all ports from C_1 (about 3 million kg.) than in the landings of the ports Grimsby and Boston (about $2^1/_2$ million kg.).

Comparison of C_1 with other areas shows, that the plaice of the landings are here essentially larger than in all the areas so far dealt with. Whilst the average weight of the plaice in A_3, B_4, B_3 and C_3 lies between 150 and 250 gm., in B_2 between 250 and 300 gm. and is about 350 gm. in C_2, it rises in C_1 to more than a pound (500 gm.). The "undersized" plaice are only represented by about 6 %, the "small" by about 30 % of the total quantity. The number of large plaice over 35 cm. amounts to about 30 %, thus just as much as the small under 25 cm. The relatively very considerable size of the plaice in the landings from C_1 is probably to be explained in part from the fact, that the northern parts off the Scottish coast lie already in the region of the *North Plaice*.

Table 11. Area C_1. English Market-Measurements 1905/08.
Principal values of the summation curves.

Month	Ext.	D	Q	M (C)	Q	D	V	Ext.
November	22	25.82	28.15	31.66	37.31	46.96	49.93	59
December	20	25.44	27.06	29.29	32.62	36.97	44.38	59
January	21	25.95	27.69	30.07	33.59	39.00	48.36	63
February	20	24.74	27.42	31.38	35.74	45.84	50.03	69
March	20	24.58	26.63	29.08	32.76	45.02	50.43	68
April	21	25.49	27.72	30.94	36.00	47.71	51.82	64
May	21	26.14	28.93	32.17	39.15	49.00	52.15	66
June	21	29.07	31.32	34.00	42.25	48.88	51.83	61
July	21	27.21	29.99	32.86	40.38	47.95	50.88	61
August	21	25.65	27.93	31.30	34.79	44.35	50.07	61
September	22	25.30	27.75	31.00	34.08	40.00	45.50	61
October	20	25.02	27.82	30.66	33.76	44.74	49.15	67
3 years	20	25.54	27.87	m 31.07 w_1 32.34	35.13	45.13	49.26	69
Averages for 4 months (one-third of year)								
I. Spring	21	26.32	28.65	31.55	37.54	47.65	51.56	65
II. Summer	21	25.79	26.37	31.45	35.75	44.26	48.90	63
III. Winter	20	25.49	27.58	30.60	34.81	42.19	48.17	62

The graphic representation of these values is given in fig. 7 C_1 Plate I.

The differences in the composition of the landings in the separate months, especially in the various seasons, are of quite a different kind, almost the reverse, to what we have found in the other areas. This is seen from Table II and also from the following summary.

Area C_1	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
	%	%	%	%	%	%	%	%	%	%	%	%
below 25 cm.	6	8	5	11	12	7	5	3	3	7	8	9
above 35 cm.	27	11	15	24	17	25	31	39	32	19	16	18

In spite of the great irregularities in these series we can see, that the large plaice of over 35 cm. in length do not have their maximum in winter, but on the contrary in spring and summer, from April to July, and that a minimum for the small plaice

below 25 cm. occurs at the same time. The minimum for the large plaice falls in winter, especially in December and January, the maximum for the small in February and March. From these results we are unable to conclude, that there is any hibernation of the small plaice in C_1 or a relative accumulation of large plaice in winter. It seems much more probable, that the largest relative quantities of large plaice occur in this area in the *summer months*.

A very remarkable characteristic of the market-samples from area C_1 is *a great irregularity in the measurement series*, both for the different months and for the whole year. In addition to a principal maximum, which lies in the neighbourhood of the median value between 27 and 32 cm., the series have also a second, small maximum (part-mode), which lies between 42 and 48 cm., in the summation curve between the upper decile and the vigintile. The depression (minimum) between the two modes lies mostly between 38 and 43 cm. and between the upper quartile and upper decile. In the graphic representation on Plate I the lines of the upper quartile and upper decile move widely from one another in consequence of this part-minimum. How these remarkable irregularities in the measurement series are to be explained, must remain uncertain meanwhile. The material of measurements for C_1 is very imperfect, especially in the first two years; but even this is insufficient to explain the typical irregularity of the series.

In C_1 even more than in C_2 there is no market-selection and the quite small plaice below 18 cm. are completely wanting. Thus, market-samples, catch-samples and stock-samples are here precisely the same.

8. **Area B_1.** *20—40 m. Dogger Bank. Central North Sea.* 6,800 square miles.

The English landings and measurements from this area in the period 1905/08 are shown in the following Table.

Area B_1 1905/08	large	medium	small	unsorted	Total
	kg.	kg.	kg.	kg.	kg.
landed	4,491,330	1,124,763	167,030	319,939	6,103,062
%	73.59	18.43	2.74	5.24	100,00
	kg.	kg.	kg.	kg.	kg.
measured	32,073	6,685	10,434	—	49,192
%	65.20	13.58	21.22	—	100.00
	nos.	nos.	nos.	nos.	nos.
	28,530	13,125	30,642	—	72,297
%	39.55	18.12	42.33	—	100.00
		60.45			

Average weight of the plaice measured.

Area B_1 1905/08	large	medium	small	unsorted	Total
	kg.	kg.	kg.	kg.	kg.
a. classes distinguished . . .	1.124	0.509	0.341	—	—
b. total	—	—	—	—	0.680

Estimated total number of plaice landed.

a. classes distinguished . . .	3,995,845	2,209,743	489,824	—	6,695,412 (without unsorted)
%	59.68	33.00	7,32	—	100.00
		40.32			
			Average weight kg. 0.864		
b. classes not distinguished .	—	—	—	—	8,504,600 (without unsorted)

The area B_1, the Dogger, is well-known as a region where a very considerable trawl-fishery of various important food-fishes is carried on. There is a great deal of fishing here and this explains the very high yield of plaice absolutely, though the density by comparison with that of the areas previously discussed is quite low. MASTERMAN gives the catch per day of voyage of steam-trawlers as 66 kg. (90), thus only about a quarter of the catches in the areas B_4, B_3 and C_3 and about the half for C_2. The plaice fishery is almost exclusively carried on by steam-trawlers; the highest catches are made in October to December, the smallest from January to March.

The total quantity of plaice landed in 1905/06 was 6,103,062 kg.; the average weight calculated without regard for the market-classes is 680 gm.; excluding the "unsorted" we obtain a total number of 8,504,600. Taking the market-classes separately the probable number is 6,695,412 plaice.

Table 12. Area B_1. English Market-Measurements 1905/08.
Principal values of the summation curves.

Month	Extr.	D	Q	M (C)	Q	D	V	Extr.
November	19	25.27	32.11	45.86	52.88	57.54	59.91	68
December	31	41.15	45.13	50.10	54.65	58.56	60.42	70
January	24	26.90	29.39	32.21	48.46	52.30	56.00	68
February	24	27.46	34.70	47.90	51.66	55.45	58.54	68

Month	Extr.	D	Q	M (C)	Q	D	V	Extr.
March	21	25.93	29.04	35.50	45.14	51.04	54.08	64
April	20	27.60	30.89	34.81	41.29	48.00	51.29	64
May	22	30.64	33.67	39.07	45.97	51.00	54.20	69
June	21	30.81	34.23	40.92	47.33	54.40	59.81	67
July	18	22.19	24.98	32.85	37.29	44.00	48.00	62
August	20	27.00	30.53	33.86	38.85	44.77	47.83	59
September	19	28.83	24.47	26.66	30.48	36.00	42.39	60
October	26	30.74	34.05	42.95	48.74	53.68	56.75	69
3 years	18	25.50	29.91	*m* 35.31 *w* 41.13	44.67	51.15	54.73	70

Fig. 8. B_1 Plate I gives the graphic representation of these values.

The representative value of the analyses (Appendix Table VIII) is not great; too many small and too few large plaice have been measured, To obtain an approximate correction we must contrast the medium+small with the large; in the measurements the numbers of these two groups are as 60 : 40, but in the landings as 40 : 60 %.

We then have the following composition according to size:

	below 23 cm.	— 25 cm.	— 26 cm.	— 29 cm.	— 31 cm.	— 36 cm.
B_1 *m*	3 %	— 8 %	— 12 %	— 22 %	— 30 %	— 53 %
w	2 -	— 5 -	— 8 -	— 15 -	— 20 -	— 30 -
C_1 *m*	2 -	— 7 -	— 12 -	— 34 -	— 49 -	— 78 -
w_1	2 -	— 6 -	— 10 -	— 30 -	— 43 -	— 68 -

The following Table shows the results obtained by MASTERMAN for the three ichthyometric ports:

Area B_1	Estimated total number of plaice landed	below 23 cm.	below 26 cm.	below 29 cm.
I. 1905/06	3,476,219	1 %	5 %	13 %
II. 1906/07	1,296,715	1 %	5 %	10 %
III. 1907/08	1,091,302	1 %	6 %	12 %
3 years	5,864,236	1 %	6 %	12 %
Weight in kg.	4,909,311			

Average weight kg. 0.837.

The summary values given by MASTERMAN are thus somewhat lower than our *w* values; according to this, there must be relatively more small plaice in the total landings of all ports, than in the landings of the ichthyometric ports. The greater average weight of the landings from all ports does not agree with this, however, amounting to 864 gm. against 837 gm. given by MASTERMAN, whereas it should be lower than the latter. MASTERMAN's calculations are possibly not quite correct, as the material from B_1, like that from C_1, is imperfect and the values for the various months in which no measurements were made, were obtained by interpolation or other means.

The plaice in the landings from the Dogger Bank are obviously *very large*, in any case considerably larger than in the areas B_4, B_3, C_3, B_2 and C_2, probably even larger than in C_1. The average weight amounts to about 850 gm. Undersized plaice (below 25 cm.) are only represented by about 5 % in the landings, the small by some 15 % only; on the other hand, the large plaice over 35 cm. in length contribute fully two-thirds of the total quantity (in C_1 barely one-third; in C_2 only about one-fifth).

The *great irregularity* in the different monthly series is very striking. There are almost always *two maxima* (modes of the curve); the first, usually the principal mode, lies between 25 and 35 cm., the second between 43 and 50 cm.; a minimum (depression) comes between 36 and 41 cm. December and January even show two completely separated curves. This resembles greatly the similar condition in area C_1 and reappears again in the areas D_1 and D_2. These irregular, multimodal curves in the composition of the landings thus appear to be a characteristic of those areas, in which the large and old plaice are predominant and the density of the plaice very small. Here the small catches absolutely, as also the scientific hauls of the research-steamers, show an irregular mixture of the most different sizes and age-groups.

The differences in the composition in the different months (Table 12) are very irregular and no longer show the typical character of the southern areas. In general, the principal values of the summation curve are highest, and thus the large plaice most numerous, in winter and lowest in summer from July to September. In the latter month especially there is a marked decrease in the large and an accumulation of the small plaice.

The graphic method of representing the variations in area B_1, Plate I, clearly shows the great irregularity in the composition of the monthly landings.

9. **Areas D_1 and D_2.** *60—80 m. Northern North Sea.* 10,200 and 12,100 square miles.

The English landings and measurements from these areas during theperiod 1905/08 are shown in the following Table.

Area D_1 and D_2 1905/08	large	medium	small	unsorted	Total
	kg.	kg.	kg.	kg.	kg.
landed	1,596,721	872,693	120,980	140,208	2,730,602
%	58.47	31.97	4.43	5.13	100.00

Area D_1 and D_2 1005/08	large	medium	small	unsorted	Total
	kg.	kg.	kg.	kg.	kg.
measured	35,333	8,930	1,747	—	46,010
%	76.79	19.41	3.80	—	100.00
	nos.	nos.	nos.	nos.	nos.
	26,507	13,589	5,528	—	45,624
%	58.10	29.78	12.12	—	100.00
		41.90			
Average weight of the plaice measured.					
	kg.	kg.	kg.	kg.	kg.
a. classes distinguished	1,333	0,657	0,316	—	—
b. classes not distinguished	—	—	—	—	1,008
Estimated total number of plaice landed.					
a. classes distinguished	1,197,840	1,328,300	382,848	—	2,908,988 (without unsorted)
%	41.18	45.65	13.17	—	100.00
		58.82			
			Average weight 0.812 kg.		
b. classes not distinguished	—	—	—	—	2,569,833 (without unsorted)

By far the greater portion of the plaice measured here come from the area D_2, the central region of the northern North Sea between 56° and 58° N. L.; very few come from D_1, the area off the Scottish coast divided from D_2 by the deep area E. The landings from both areas are almost equal (see Table I, p. 70). We may take the two areas together. The plaice fishery here is exclusively carried on by steam-trawlers and is naturally of a subordinate kind; the greatest quantities are obtained in the months of February to June. The average catch per day of voyage of steam-trawlers is estimated by MASTERMAN to be about 33 kg. (90), that is, the density of the marketable plaice here is only about half what it is on the Dogger Bank.

The total quantity of plaice landed from D_1 and D_2 in 1905/08 amounted to 2,730,602 kg.; disregarding the unsorted the average weight calculated from the measurements is 1,008 gm.; taking all the classes together this gives a total number of 2,569,833 plaice, and if the classes are considered the probable number is 2,908,988. Relatively too many large plaice have been measured, too few medium and small; most

measurements were made in *Boston*. The relative proportions of these two groups by weight are 58 : 36 in the landings, 77 : 23 in the measurements; by number 41 : 59 and 58 : 42.

We have the following summation values of the different size-groups, *m* calculated from the analyses in Appendix Table IX and *w* corrected by means of the above proportions.

$D_1 + D_2$		below 23 cm.	— 25 cm.	— 26 cm.	— 29 cm.	— 31 cm.	— 36 cm.
	m	0.2 %	— 0.6 %	— 1 %	— 4 %	— 8 %	— 18 %
	w	0.3 -	— 0.8 -	— 1 -	— 6 -	— 11 -	— 25 -
B_1	*m*	3 %	— 8 %	— 12 %	— 22 %	— 30 %	— 53 %
	w	2 -	— 5 -	— 8 -	— 15 -	— 20 -	— 35 -

MASTERMAN's calculations (101) only refer to the landings from D_2 in Boston, where the great majority of the measurements have been made and the largest quantities of plaice landed from area D. He gives for the sum of the three years:

Area D_2	Estimated total number of plaice landed	below 23 cm.	below 26 cm.	below 29 cm.
3 years	253,618	1 %	6 %	17 %
Weight kg.	163,071			
Average weight kg. 0.643				

These results do not agree with our *m* or *w* values. In the Boston landings, consequently, there were relatively very many more small plaice than in our mixed series, though almost the same measurements have been used. A certain difference is to be expected, it is true, but hardly one so great and so sharply marked, that MASTERMAN obtains only 643 gm. as average weight, whilst the measurements for the total landings give a probable average weight of 812 gm. The Boston landings, so far as they were investigated, must therefore, in all probability, have contained many more small plaice than the landings of all ports.

The landings from area D_2, which formed the basis of MASTERMAN's calculations, amounted in the three years to 163,071 kg.; the total landings of all ports used in our calculations, with exclusion of the unsorted, amounted to 2,590,394 kg., thus more than 15 times as much. According to our calculations there are relatively fewer small plaice in the D areas than in B_1; according to MASTERMAN, the reverse is rather the case. It will be difficult to decide, what the actual condition is. When such a difference appears in the results, it has to be remenbered, that in the case of such extensive areas as D_1 and D_2 it will be extremely difficult to obtain accurate values for the average, which would be applicable to the whole area. These large areas are so different in themselves, containing such a variety of fishing-grounds, that we cannot accept without

question the market-samples measured as in all cases representative for the market-classes landed, for it is seldom known in either case from what part of the area the samples or landings come.

For *practical* purposes, however, these differences are of no importance. It is certain, that D_1 and D_2 are areas in which the undersized and small plaice are quite subordinate, just as in B_1 and probably even more so. On the other hand, the large plaice, over 35 cm. in length, probably amount by number to three-fourths of the total quantity.

Table 13. Areas $D_1 + D_2$. English Market-Measurements 1905/08. Principal values of the summation curves.

Month	Extr.	D.	Q.	M. (C.)	Q.	D.	V.	Extr.
November	27	35.00	37.46	40.64	45.04	49.82	53.23	69
December	34	37.48	38.44	40.64	43.85	46.97	49.57	60
January	25	27.99	29.23	31.68	32.84	34.66	35.54	38
February	26	29.24	31.96	35.30	40.73	51.56	54.26	66
March	22	27.55	30.22	45.67	50.39	54.66	57.18	64
April	20	24.49	27.24	29.81	42.17	55.09	57.44	64
May	23	39.68	43.81	47.66	51.00	54.89	57.73	70
June	26	38.30	42.34	46.48	50.28	53.83	56.67	70
July	20	30.95	37.73	42.16	47.65	51.94	54.54	70
August	25	30.03	32.21	39.35	47.04	51.66	54.29	70
September	26	31.79	35.61	40.03	44.81	44.28	52.20	70
October	27	30.44	32.20	38.42	44.00	48.78	51.08	57
3 years	20	32.25	38.49	*m* 44.37 *w* 41.00	49.13	53.10	55.79	70

The graphic representation of these values is given in fig. 9 D on Plate I.

As already remarked above, the measurement series for the different months are very irregular in D just as in C_1 and B_1, and usually have two separate maxima. This is also still seen in the somewhat smoother curve for the year; here the one maximum lies at 30 cm., the second at 48 cm. Two groups of plaice are thus present in reality, one of which may be called the small-medium, the other large. In the March measurements the two groups are completely isolated, in December only the group large is represented, in January only the small-medium. The large plaice, and also the largest e. g. over 50 cm. in length, occur in greatest quantity both absolutely and relatively from May to September, thus in summer, whilst they are scarcest in December and January.

These conditions are shown clearly in the graphic method of representation (fig. 9 Plate I).

10. **Area E.** *80—100 m. Northern North Sea.* 16,500 square miles.

The landings and measurements from this deep area, which extends down from the north as far as 55° N. L., are very small in number and quantity. In 1905/08 only 497,129 kg. were landed, including 37 % large, 56 % medium and 7 % small. According to the measurements, which were only made in the year 1907/08 in Boston (about 1,070 plaice spread over some months), the large have an average weight of 1.332 kg., the medium 0.726 kg. and the small 0.335 kg. (102). From this we may estimate the total number of plaice landed to be about 613,000 with an average weight of 811 gm. This average weight is the same as that found for area D. The analysis of the measurements, which is not reproduced here, shows a difference from area D in so far, that small plaice below 26 cm. are not at all present in the measurements and fewer also occur under 36 cm. The smallest plaice caught by the research-steamers in E measured 37 cm.

Comparison of the different areas.

The English investigations on the composition of the landings from the different areas of the North Sea lead without any doubt to the important result, that each single area as also several groups together show quite special characteristics, knowledge of which is of great importance for practical purposes in our search for suitable size-limits. This can be seen best from the following summary based upon the results of the preceding sections.

Table 14. English Market-Measurements 1905/08.
Comparison of the average yearly quantity and composition of the plaice landings from the different areas of the North Sea.

Area	1905/08 Yearly landings		1905/08 average weight of plaice	1905/08 Range in length of plaice measured	1905/08 Interval of		Probable percentage of the total number below							Percentage of "small" by weight	Catch of steam-trawlers per day of voyage
	kg.	estimated number			mode	median	23 cm.	25 cm.	26 cm.	29 cm.	31 cm.	36 cm.	51 cm.		
	1000	1000	kg.	kg.											kg.
A_3	2165	14,091	0.153	16—45	24	24	26	55	68	95	97	99	100	86	492
B_4	4090	21,656	0.189	16—71	24	25	20	43	55	84	92	99	99.8	76	294
B_3	6845	33,294	0.206	15—71	24	26	20	39	48	68	78	94	99.1	42	263
C_3	2153	9,408	0.229	17—69	25	26	17	37	48	67	77	93	99.9	31	287
B_2	3280	12,197	0.269	17—67	26	28	9	24	32	55	66	87	99.8	27	164
C_2	6082	16,671	0.365	17—76	28	29	5	15	20	41	54	78	98.4	25	116
C_1	1003	1,893	0.529	20—69	30	32	2	6	10	30	43	68	95.2	9	89
B_1	2034	2,229	0.865	18—70	32	41	2	5	8	15	20	30	85.0	3	66
D_{1+2}	910	970	0.812	20—70	48	41	0 3	0.8	1	6	11	25	88.3	4	33
E	166	204	0.811	26—66	50	48	—	—	—	—	—	—	—	6	17
Total	28,728	112,613	0.255	15—76											

Table 15. English Market-Measurements October 1905 to March 1909. Calculation of the estimated total number and total weight of the landings in the ichthyometric ports (from MASTERMAN, *Plaice Fisheries Vol. III p. 53).*

Area		Number and weight of the landings	Percentage below			Average weight kg.
			23 cm.	26 cm.	29 cm.	
$A_3 + B_4$	Number	76,324,917	19	56	84	
	Weight kg.	13,973,611	10	40	70	0.183
B_3	Number	117,076,891	22	55	78	
	Weight kg.	22,175,877	10	33	55	0.190
C_3	Number	25,432,376	16	43	65	
	Weight kg.	5,833,793	6	21	38	0.230
C_2	Number	51,286,189	7	30	55	
	Weight kg.	15,663,870	2	13	30	0.352
B_2	Number	35,239,767	9	29	50	
	Weight kg.	10,356,087	3	13	29	0.293
B_5	Number	12,628	0.3	5	24	
	Weight kg.	6,097	0.0	1	9	0.483
C_1	Number	5,525,037	1	8	22	
	Weight kg.	2,811,625	0.2	2	8	0.509
D_2	Number	253,618	1	6	17	
	Weight kg.	163,071	0.2	1	5	0.643
B_1	Number	6,250,569	1	5	13	
	Weight kg.	5,154,827	0.1	0,9	3	0.825
Sum	Number	317,401,992	16	46	66	
	Weight kg.	76,138,858	6	23	42	0.240

For the sake of comparison I give here the calculations of MASTERMAN for the whole period from October 1905 to March 1909, both for numbers and weight. The agreement is satisfactory for both calculations, at least so far as the principal areas are concerned and especially in regard to the average weights. The measurements in the period from 1st October 1908 to 1st April 1909 could not be used by me, as they have not yet been published.

We may distinguish between three groups of areas according to the size of plaice and the composition of the landings.

1. *The four areas A_3, B_4, B_3 and C_3 form (with A_2) the southern plaice zone of the North Sea lying nearest the land.* By weight and number this zone yields the greatest quantity of plaice, namely, each year about 15 million kg. and 75 million plaice with an average weight of about 200 gm. The most frequently occurring size (mode) of the plaice measured lies at 24—25 cm., the median or central value at 24—26 cm. More than *one-third* of all plaice (37 to 55 %) are below 25 cm. in length and may be called *undersized*, more than *two-thirds* are under 29 cm. long and may be called *small* plaice. The *large* plaice, i. e. those over 35 cm. in length, amount to less than 8 % (7 to 1 %); the largest and oldest, over 50 cm. in length (mostly over 10 years old) less than 1 %. This zone therefore is the region of the undersized and small plaice.

Here — as shown by the scientific hauls — large quantities of plaice are caught, which are under the legal or ordinary size-limit of 18 cm. and are thus thrown overboard again, without being brought to market. This is the region, therefore, in which an extensive and useless destruction of enormous quantities of small, immature, undersized plaice is constantly going on.

2. *The two areas B_2 and C_2 form the middle plaice zone of the North Sea.* Almost of the same extent as the first zone, it gives yearly only about 9 million kg. and only 29 million plaice, which, however, are essentially larger with an average weight of about 300 kg. The most frequent size (mode) of the plaice measured lies at 26—28 cm., the median or central value at 28 to 29 cm. Only about a fifth of all plaice are below 25 cm. in length and barely half below 29 cm. Large plaice, i. e. over 35 cm., amount to about 10 to 20 %; the largest and oldest, over 50 cm., about 1 to 2 %. The useless destruction of small, unmarketable plaice is here extremely limited and only occurs in certain parts of B_2. The question of protective regulations is thus no longer vital here.

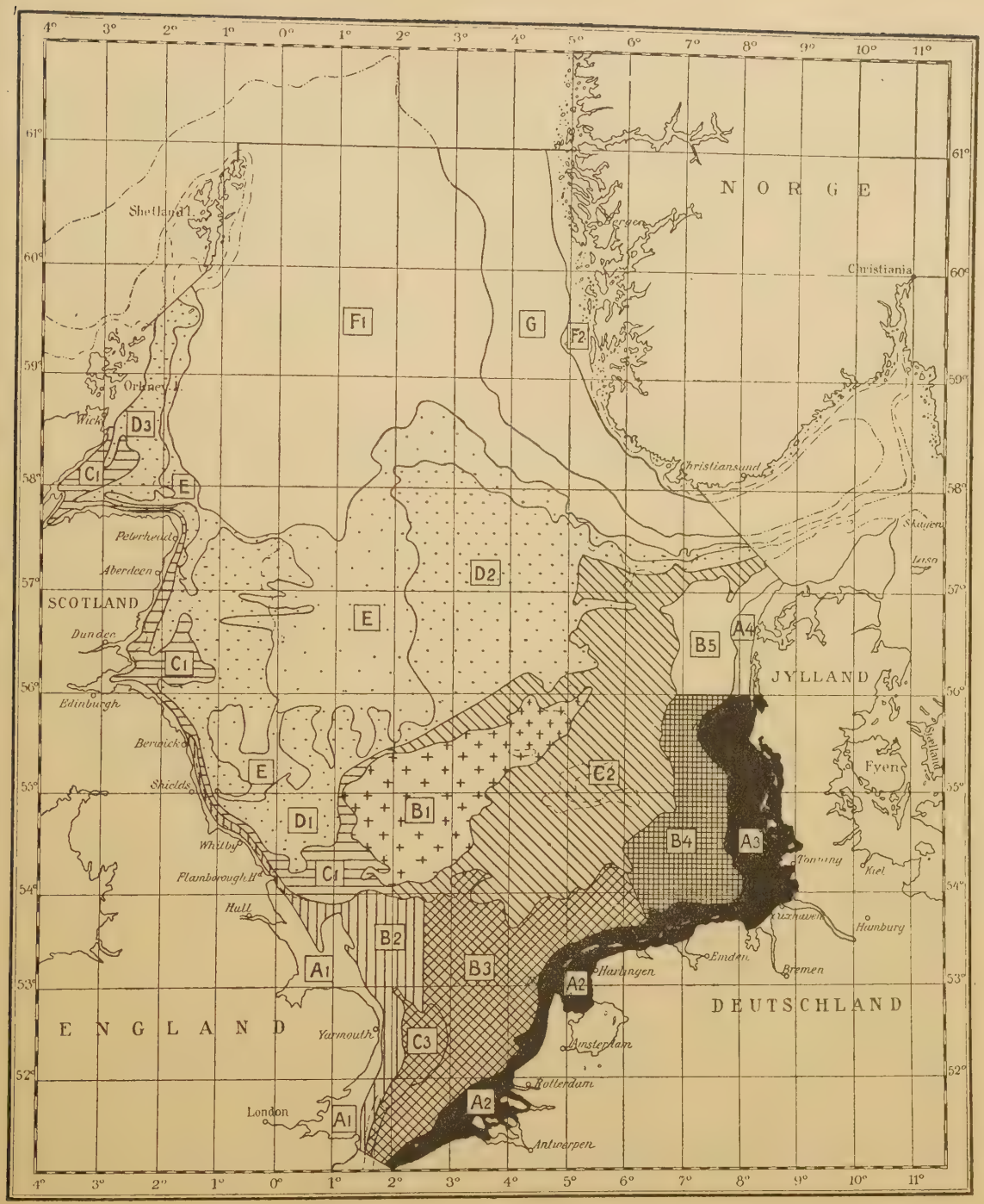
3. *The areas C_1, B_1, D_1 and D_2 and E form the outermost, most northerly plaice zone of the North Sea.* In extent this zone is about as great as the two previous together; in the landings it is only represented by a yearly quantity of 4 million kg. and 5 million plaice, but these are large with an average weight of about 800 gm. The number of undersized plaice (below 25 cm.) amounts here only to 0—6 %, that of the small (below 29 cm.) to at most three-tenths of the total number. The large plaice contribute 25 to 70 %, the very large 5 to 15 %. According to the scientific hauls, quite small plaice below 18 cm. are practically never taken in this zone; in C_1 only a few may appear in the trawl. The question of protection has lost all importance in this zone.

Within each of the three plaice zones of the North Sea there are various subdivisions, the areas themselves, which again differ in that the size of the plaice and the percentages at the different sizes vary according to the depth of the area and its distance from the coast.

The cyclic method of representing the differences graphically, Plate I, gives a good picture of the composition of the landings in the different areas, though revision is desirable for most areas. Nevertheless, the common character of the four areas of the first zone is apparent at the first glance in the course of the lines. Likewise the common and different character of the second zone, B_2 and C_2, and lastly, the character of the third zone is specially well-marked in the irregular course of the lines, which, present already in C_1, appears very distinctly in B_1 and D.

In fig. XIII on Plate IV the yearly principal values for the various areas are represented graphically on the cyclic method. Here, instead of the months, the areas are taken as the radii of a circle and the principal values of the yearly series are marked off on these radii as abscissae. The areas are so placed, that one of the diameters of the circle represents the middle zone B_2 and C_2, the areas of the northern zone lying above to the left, those of the southern below to the right. In this way we obtain a very clear perception of the differences in the yearly landings from the different areas. The connecting lines of the principal values, e. g. of the median or central value, form characteristic ovals, the broader pole lying in the south zone, the more pointed in the north zone.

The figures I to XII of Plates II—IV have been constructed in the same way, namely with the areas as radii of the circle. These figures I to XII show the composition of



A2, A3	B4	B3, C3	B2	C2	C1	B1	D, E
/o							
cm > 50 %	= 40—50 %	= 30—40 %	= 20—30 %	= 10—20 %	= 5—10 %	= 5—10 %	= 0—1 %.
cm 1 %	= 1—2 %	= 5—10 %	= 10—20 %	= 20—30 %	= 30—40 %	= 60—70 %	= 75 % +.

Fig. 21. *English Market-Measurements 1905/08.* Relative quantities (in percentage of the total number) of small, "undersized" plaice below 25 cm. and of large, mature plaice over 35 cm. in the English landings from the different areas of the North Sea.
The blank areas have not been investigated.

the landings from the different areas for each of the 12 Months of the year; Plate II for the 4 winter, Plate III for the 4 spring and Plate IV for the 4 summer months. The differences in the course of the lines in these 12 figures represent the characteristic differences existing between the landings from the different areas in the same month; and a comparison of the separate figures gives a picture of the successive changes from month to month in the distribution of the landings over the different areas of the North Sea, a subject that will be dealt with in more detail in the following section.

Fig. 21 gives a cartographic representation of the relative quantities of small plaice below 25 cm. and of large plaice above 35 cm., which are present in the landings from the different areas.

b. Composition of the landings in the different months from the whole North Sea.

The discussion of the composition of the landings from the different areas, given in the preceding section, has not yielded us any certain results, because the composition of the plaice measured by weight does not always agree sufficiently well with that in the areas. In some areas relatively too few, in others too many small plaice have obviously been measured. The errors arising in this way counterbalance one another to a great extent, when we take together the measurements of all the areas, that is, *regard the whole North Sea as one region without divisions*. For the investigation of the composition of the plaice stock in the North Sea, and for this purpose we must also make use of the landings, such a combination of the areas is even essential. For the plaice population of the North Sea is composed of very different groups, with regard to size and age, which are distributed over the entire North Sea according to the known law of distribution of the plaice.

We may first consider the measurements for the three years 1905/08 from the whole North Sea *arranged according to the months*. From what has been shown earlier in Section 2 p. 76 as also from the fact, just mentioned, that the different areas counterbalance one another when combined, we may assume, that the representative character of the monthly series of measurements is satisfactory.

Tables X to XIII of the Appendix contain the English measurements from the whole North Sea, firstly, for each month of each of the three yearly periods, namely October 1905/06, October 1906/07 and October 1907/08 and secondly, as the sum for the entire period October 1905/08. The monthly series are given here in absolute numbers, the yearly sum in absolute and relative numbers.

In the following Tables of the text, 16 to 19, the principal values of the monthly series and of the yearly series are arranged in the same manner for the whole North Sea as in the preceding Section for the separate areas.

Tables 16 to 19. Whole North Sea. English Market-Measurements. Principal values of the summation curves according to months, four monthly periods and for the whole year.

Table 16. 1st year October 1905/06.

Month	Extr.	D	Q	M(C)	Q	D	V	Extr.
November	17	21.24	23.80	26.12	28.87	32.00	34.43	63
December	18	22.33	24.47	27.08	30.41	33.91	36.58	68
January	17	22.83	25.18	28.77	32.60	36.21	39.24	69
February	17	14.83	22.91	26.83	32.53	37.12	40.84	69
March	17	20.53	22.20	24.37	27.24	31.28	34.69	67
April	15	20.83	22.58	24.81	27.71	30.73	32.80	67
May	16	21.01	22.75	25.27	28.41	31.71	34.00	64
June	17	21.29	22.89	25.34	29.00	33.36	37.46	68
July	17	21.80	23.60	26.87	31.17	36.00	40.00	67
August	19	22.81	24.65	27.51	31.30	35.82	39.70	65
September	18	22.58	24.29	26.81	30.49	34.81	38.60	60
October	16	21.64	23.19	24.93	26.85	28.88	30.35	50
Whole year	15	21.48	23.37	25.94	29.46	33.56	35.74	69
Averages for 4 months (one-third of year).								
I. Spring	17	20.92	22.69	24.95	28.09	31.77	34.74	67
II. Summer	18	22.21	23.94	26.48	29.95	33.88	37.16	60
III. Winter	17	21.94	24.09	27.20	31.10	34.81	37.77	67

Tab. 17. 2nd year. October. 1906/07.

Month	Extr.	D.	Q.	M. (C.)	Q.	D.	V.	Extr.
November	17	22.36	24 10	26.66	30.80	41.00	47.70	69
December	18	22.05	23.86	26.35	30.20	37.55	44.10	70
January	18	22.43	24.48	27.84	32.27	38.93	44.56	70
February	18	22.37	24.64	28.08	32.53	38.79	45.65	69
March	17	22.35	24.16	26,72	30.38	35.85	43.43	70
April	17	21.97	23.74	26.50	30.48	35.59	41.10	76
May	17	21.86	23.41	25.75	29.23	33.30	40.84	70
June	18	22.21	23.94	26.31	29.83	34.00	42.42	70

Month	Extr.	D.	Q.	M. (C.)	Q.	D.	V.	Extr.
July	18	22.74	24.93	27.84	31.31	35.00	38.80	66
August	18	23.15	25.52	28.74	32.54	37.00	41.76	70
September	18	22.52	24.34	27.91	30.86	35.35	40.48	70
October	17	22.38	24.19	26.77	30.89	37.70	42.75	69
Whole year	17	22.28	24.15	26.91	30.80	36.14	42.51	76
Averages for 4 months (one-third of year).								
I. Spring	17	22.10	23.81	26.32	29.98	34.68	41.95	71
II. Summer	18	22.70	24.74	27.81	31.40	36.26	40.95	68
III. Winter	18	23.00	24.27	27.23	31.45	39.07	45.50	70

Tab. 18. 3rd year. October. 1907/08.

Month	Extr.	D.	Q.	M. (C.)	Q.	D.	V.	Extr.
November	18	22.67	24.66	27.25	31.37	37.13	45.33	71
December	18	23.19	25.01	27.69	31.78	38.20	45.00	71
January	18	23.14	25.15	28.07	32.13	37.63	43.35	71
February	18	22.36	24.37	27.39	32.49	39.33	45.84	71
March	16	21.91	23.73	26.49	30.64	35.84	41.72	70
April	16	22.12	23.88	26.28	30.23	34.12	37.00	69
May	18	22.07	23.87	26.55	30.49	34.57	39.70	69
June	17	22.15	24.12	26.94	30.53	34.24	37.49	66
July	18	22.60	24.88	28.07	32.30	36.26	39.90	70
August	17	22.41	24.71	28.03	31.85	35.40	38.28	70
September	18	22.74	24.58	27.58	31.34	35.40	38.52	65
October	18	23.03	24.76	27.50	30.89	35.40	42.42	70
Whole year	16	22.47	24.43	27.29	31.27	35.72	40.87	71
Averages for 4 months (one-third of year).								
I. Spring	17	22.06	23.90	26.57	30.47	34.69	38.98	68
II. Summer	18	22.69	24.73	27.79	31.59	35.61	39.78	69
III. Winter	16	22.84	24.80	27.60	31.94	38.07	44.88	71

Tab. 19. 3 years. October. 1905/08.

Month	Extr.	D.	Q.	M. (C.)	Q.	D.	V.	Extr.
November	17	22.30	24.16	26.57	30.13	35.25	42.20	71
December	18	22.47	24.42	27.04	30.81	35.97	42.59	71
January	17	22.80	24.94	28.20	32.33	37.46	42.93	71
February	17	21.88	24.12	27.55	32.51	38.37	44.28	71
March	16	21.49	23.34	25.86	29.59	34.50	39.86	70
April	15	21.60	23.38	25.86	29.51	33.57	36.89	76
May	16	21.61	23.33	26.20	29.32	33.15	37.59	70
June	17	21.86	23.58	26.15	29.80	34.26	38.00	70
July	17	22.34	24.47	27.59	31.59	35.74	39.58	70
August	17	22.77	24.93	28.08	31.92	36.00	39.74	70
September	18	22.61	24.40	27.15	30.90	35.20	39.00	70
October	16	22.29	23.98	26.17	29.50	33.90	39.36	70
Whole year	15	22.10	23.98	26.70	30.57	35.13	39.74	76

Averages for 4 months (one-third of year).

Month	Extr.	D.	Q.	M. (C.)	Q.	D.	V.	Extr.
I. Spring	16	21.64	23.41	26.27	29.55	33.87	38.08	71
II. Summer	17	22.50	24.44	27.25	30.98	35.21	39.42	70
III. Winter	17	22.36	24.41	27.34	31.44	36.76	43.05	71

These summaries show, in the first place, that the year 1905/06 is essentially different from the two years 1906/07 and 1907/08. The plaice measured in the first year are on the whole smaller than in the two following years. This is shown by the fact, that the principal values of the summation series are considerably lower in the corresponding months, in the four-monthly periods and in the whole year 1905/06 than in 1906/07 and 1907/08. On the other hand, the last two years are in good agreement as regards all the principal values. As already mentioned several times, the divergent character of 1905/06 arises from the fact, that in that year — in the beginning of the ichthyometric work — a much greater proportion of the small and smallest plaice were intentionally measured, especially in the first months from October to June. As a result the lower decile and quartile are for this period abnormally high by comparison with the other years. The good agreement existing, on the other hand, between the values of the two years 1906/07 and 1907/08 is clearly a sign, that in these two years the method of the measurements and the selection of the market-samples have been pursued on a sufficiently systematic plan to give representative values.

With regard now to the differences in the composition of the landings during the course of the year, we have the following result. In almost *every year* as in the average of the three years the *principal values* of the summation series have *two maxima* and *two minima*. The first and larger maximum falls in the winter, January to February, the second and somewhat smaller half a year later, in the summer, July to August. The first and larger minimum falls in the spring, from March to May between the winter and summer maxima. The second, much less well-marked minimum lies in autumn, mostly in October and November. *These periodical fluctuations in the height of the principal values indicate, in words, that in the landings a rise and fall in the number of small plaice by comparison with the larger occurs twice in the year.* The relative number of small plaice in the landings rises in the spring and autumn and that of the larger plaice in winter and spring. The cyclic method of representing such fluctuations graphically, especially fig. XIV of Pl. IV — the composition of the monthly landings from the whole North Sea — shows these relations very clearly in the double rise and fall in the course of the lines connecting the principal values.

For reasons already explained, the sum of the landings for the three years 1905/08 gives possibly the best representation of the true composition and the following have been arranged mainly to show this.

Table 20. English Market-Measurements and Landings for the period 1905/08, according to months.

a. Monthly percentage at the different sizes in the total landings, by number.
b. Monthly percentage of the different market-classes in the total landings, by weight.
c. Quantity of the landings, in 1000 kg. All for the whole North Sea.
(calculated from "Plaice Fisheries", Vol. I, Table VII, Vol. II, Tables VI and XLVI).

Month	a. % of the total number below							b. % of the landings in kg.		Total of the landings 1000 kg.
	23 cm.	25 cm.	26 cm.	29 cm.	31 cm.	36 cm.	51 cm.	large + medium + others	small	
November . . .	14	34	45	68	79	91	98.6	60	40	9,049
December . . .	13	35	46	65	76	90	98.9	70	30	6,313
January	12	25	33	56	68	87	98.6	77	23	5,802
February	17	32	39	58	69	86	98.3	76	24	4,540
March	21	42	51	72	81	92	99.1	77	23	4,853
April	22	42	51	72	82	94	99.5	65	35	6,212
May	22	42	52	75	83	94	99.2	49	51	8,834
June	19	39	49	70	81	93	99.2	40	60	10,301
July	14	29	38	59	70	91	99.5	52	48	10,134
August	11	25	34	57	70	90	99.5	65	35	9,157
September . . .	13	31	45	63	76	92	99.6	64	36	8,890
October	15	37	48	72	82	93	99.3	64	36	9,879
Whole year	17	35	44	66	77	91		Total		93,964
								Monthly average		7,830

Table 20 and the curves of fig. 22 give a comprehensive picture of the difference in the summation values at the different sizes and of the amount of the plaice landings and the proportion of small plaice in these landings, arranged according to the different months and as the sum of all three years. It will be seen that:

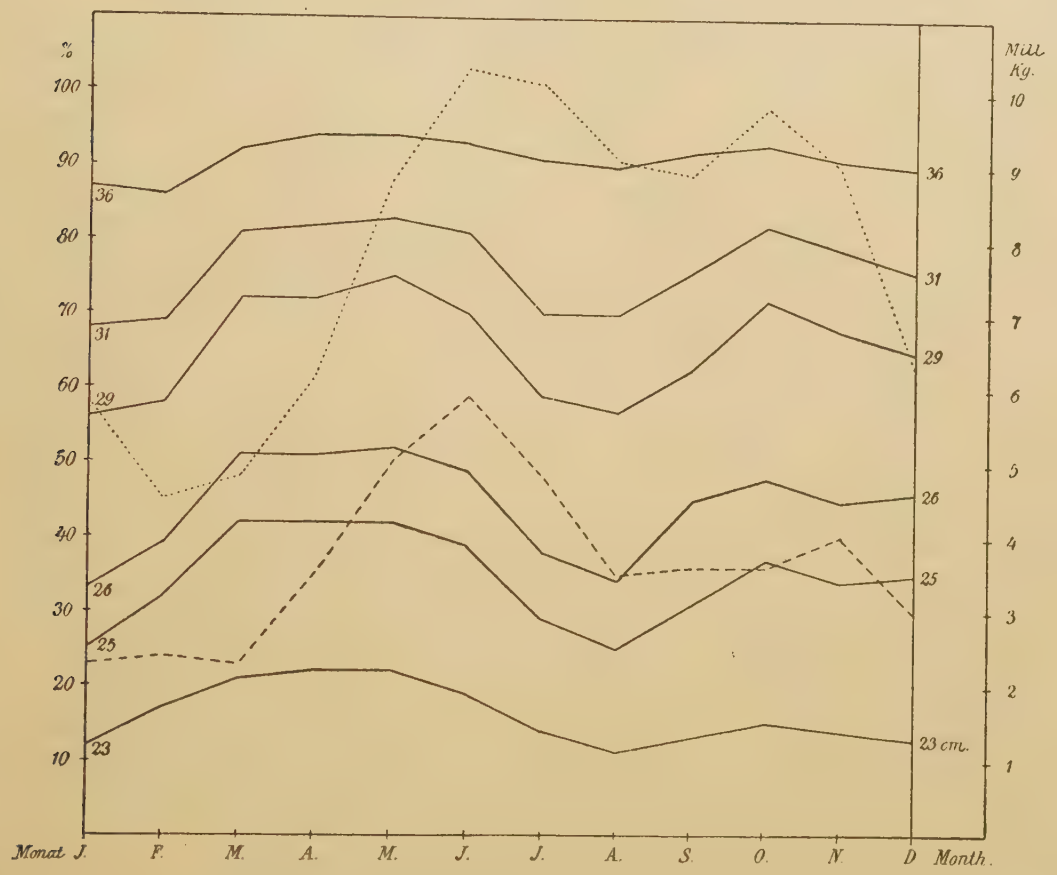


Fig. 22. English Market-Measurements 1905/08.

a. ———— Percentage by number below 23, 25, 26, 29, 31 and 36 cm. in the total measurements for the three years; by months.

b. — — — — — Percentage by weight of the market-class "small" in the total landings of the three years; by months.

c. ..... Total landings in million kg.; by months.

1. *The quantity in kg. of the English landings from the whole North Sea is very different in the different months of the year.* The maximum falls in the summer (June, July), the minimum, scarcely half as great, in the winter (February, March). In addition to the maximum in June there is a second, secondary maximum in October (September to November) and a corresponding minimum from August to September. The differences between the two are small.

2. *The greater the absolute quantity of the landings in a month, the higher in general is the percentage by weight of the "small" plaice in these landings.* This means, in general, than the large catches contain by weight relatively many more plaice of the class "small" than the small catches. The curve of the absolute quantities landed and

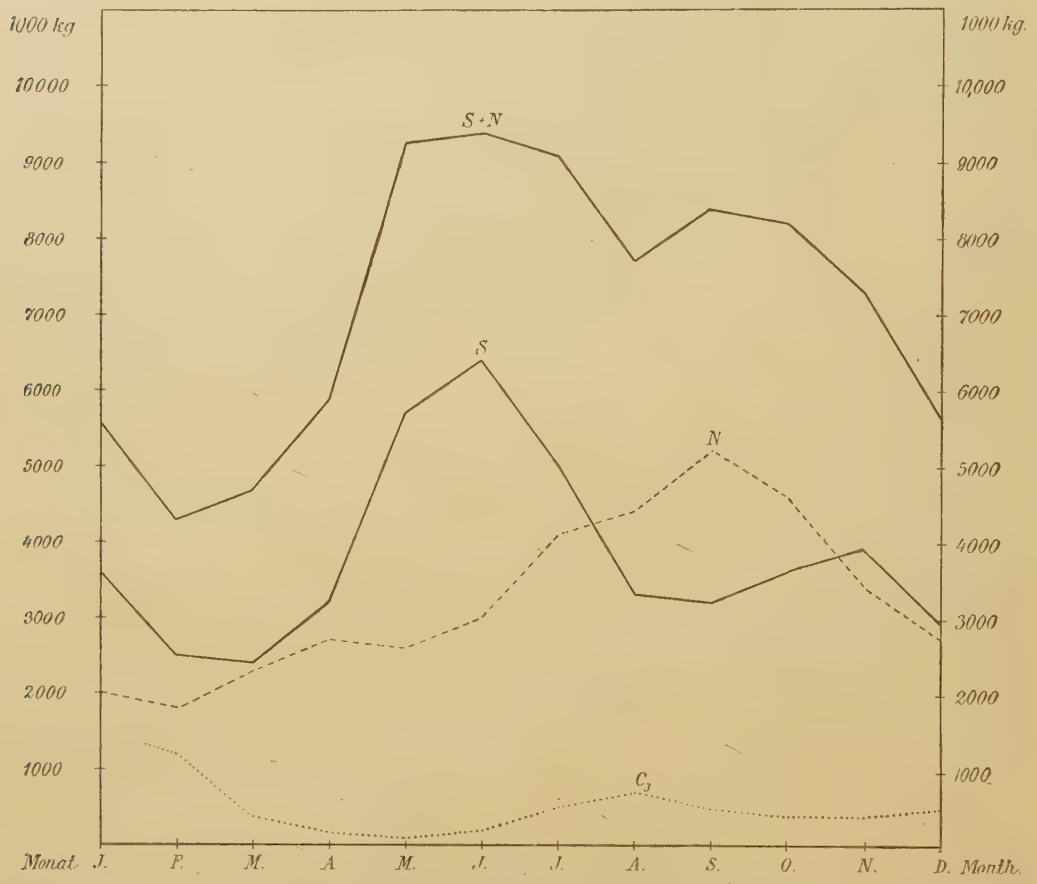


Fig. 23. English Market-Measurements 1905/08.

Absolute quantities by weight of the landings in the three years from different areas of the North Sea; by months.

S ———— southern zone. Areas A_3 — B_4 — B_3 — C_3.
N — — — — — northern zone. Areas B_1 — C_1 — C_2 — D_1 — D_2 — E.
C_3 . . . . . Area C_3 alone.
S + N ———— sum total of south and north zone.

that of the percentage by weight of the small plaice follow a similar course; in both the principal maximum and principal minimum are respectively in June and winter, the secondary in October—November and August—September.

3. *The greater the absolute monthly landings and the greater, correspondingly, the relative quantities by weight of the small plaice in the different months, the greater*

is the relative number of the small plaice. The curves of the sum totals for the different sizes, e. g. below 29 cm. (called by us "small" plaice), follow throughout a similar course to those of the quantities by weight and show the same elevations and depressions. The agreement is not so great, however, that the same percentage by weight of "small" in two months always has the same percentage by number. In August, for example, the small plaice are represented by a considerably smaller number than in April, though the quantities by weight are the same (p. 98).

For a closer understanding of these, not unimportant differences in the landings, it is also necessary to remember the similar differences, which have been discussed for the different areas in the preceding section. In the southern zone of the North Sea, the areas B_4, B_3 and C_3, we found a minimum for the small plaice in winter, a second in the middle of summer, a maximum in spring and a second in autumn. In the middle zone, the areas B_2 and C_2, these differences are only just indicated; the minimum in summer and the adjacent maximum in autumn especially cannot be distinguished with certainty; only a minimum in winter and a maximum in spring remain distinct. In the northern zone, the areas $B_1 - C_1 -$ D and E, the winter minimum and the spring maximum have also become indistinct.

It is also of interest to compare the quantities of the landings from the different areas in the various months. For this purpose we may take the areas in *two* groups, a southern with A_3, B_4, B_3 and C_3 and a middle and northern with B_2, C_2, C_1, B_1, D and E together. As will be seen from the graphic summary in fig. 23, which has been drawn up from the English market statistics, the two groups are essentially different. In the south of the North Sea, the zone of the small plaice, the largest catches are made in the period from April to August, in the north, the zone of the large plaice, on the other hand, from July to October and in these months even more plaice absolutely are landed from here usually than from the southern zone in the same period. In October, however, the southern North Sea begins once more to yield larger quantities than the northern and this condition remains throughout the winter until July. Both zones give the smallest yield in winter, but there is here a remarkable exception, namely the area C_3, the quantities landed from which are shown separately in fig 23 by a dotted line. In C_3 by far the largest quantities of the whole year are taken in the months of January and February; this is obviously connected with the fact, that C_3 is the principal spawning-region, on which an extremely dense accumulation of plaice occurs at the spawning-time.

Taking all these facts together, we may construct the following picture of the extent and yield of the plaice fishery in the North Sea and of the composition of the landings in the course of the year (p. 98).

In *winter* the English plaice fishery in the whole North Sea is small in amount except in the area C_3 (and a part of B_3), where great accumulations of plaice during the *spawning-time* result in large catches. The smaller catches of the winter fishery bring in relatively very few small plaice, even in the southern zone, where in spring these occur in greatest abundance. The explanation why these are not taken in winter can scarcely be other, than that they bury themselves in the ground and thus hibernate. For the whole North Sea the winter landings contain about 31 % below 25 cm. and 62 % below 29 cm.; but on the other hand 10 % over 35 cm.

In *spring* (April) a very intensive plaice fishing begins in the North Sea, increasing rapidly and continuously to June and then slowly decreasing again to the April level in December. In the first four months, April, May, June, July, this fishery is mainly carried on in the southern North Sea and thus yields large quantities and still larger numbers of small plaice, which occur in greatest abundance and in very dense shoals while seeking their food, with about 41 % below 25 cm. and 72 cm. below 29 cm., and only about 6 % over 35 cm. in length.

In *summer*, from June onwards, the yield in the southern North Sea declines to a minimum in August and simultaneously that of the northern North Sea rises; in August, already, the latter exceeds the former. In other words, from June onwards the plaice fishery gradually moves for a great part northwards and reaches its highest yield here in September. This displacement of the principal plaice fishery northwards must result in a relative decrease of the small plaice in the landings, for the plaice of the northern zone are on an average considerably larger than those of the southern zone. This decrease will appear most distinctly, when the yield from the southern zone reaches its lowest point and that of the northern zone its highest point, that is, some time in August and September. In these two months, in fact, we find only about 28 % below 25 cm. and only 60 % below 29 cm., with 10 % over 35 cm., thus true winter values. The displacement of the principal plaice fishery from the southern to the northern North Sea in the course of summer is possibly connected with the fact, that the regular, yearly migration of the plaice seawards occurs mainly in the summer from June onwards and that it is chiefly the larger, more active, adult plaice which take part in this migration or that the plaice which have migrated further out to sea grow very rapidly on certain outer grounds of the North Sea, for example, on the Dogger Bank.

In *autumn*, from September onwards, the yield of the fishery again decreases in the northern North Sea and increases in the southern. This rise in the quantities from the southern zone is connected with a renewed increase in the small plaice, which reaches its maximum in October and November. This new, secondary maximum of the small plaice chiefly occurs in the areas A_3, B_3 and B_4, especially in the last. The following is perhaps the explanation of this. The seaward migration from these areas A_3, B_4 und B_3 probably ceases with the beginning of autumn; at the same time, however, these receive from the quite shallow coastal regions, which are little or not at all fished by the trawl, a large increment of the small plaice, which have grown up over the ordinary size-limit of the trawl-fishery, namely 18 cm., and are thus about $2^1/_2$ years old. In this way dense accumulations of small plaice appear once more and are able to support a profitable fishery until the end of October or November, that is, until the winter rest begins.

The general result of this section is, that the amount and composition of the English plaice landings from the North Sea in the different months of the year are dependent on the course of the fishery, which again follows the local accumulations, varying with the season, of the marketable and catchable plaice. We thus have *three* principal fishing districts, separated both regionally and seasonally; the most productive, yielding the largest quantity of small plaice, in spring in the areas A_3, B_4 and B_3 of the southern North Sea, the next in productiveness, with essentially larger plaice, in summer and autumn in the central and northern North Sea and lastly, the smallest

both in area and thus in yield, in winter in the spawning-region of the southern North Sea, area C_3 and a part of B_3.

c. Composition of the landings from the whole North Sea in one whole year.

The combination of all the plaice measured in one year into a single series is best suited to give us an adequate picture of the composition of the total landings. We may expect, and the discussions of the preceding sections made it already probable, that the throwing together of all the measurements from all English ports, all areas and all months would tend to smooth out many errors arising from the imperfect selection of the market-samples; and that, consequently, these *yearly series* for the whole North Sea would possess a higher representative value than the series for the separate ports, months and areas. For certain, practical questions, e. g. the determination of an *international* size-limit, further, it is of more importance to know the composition of the landings of the whole year from the whole North Sea, than those of separate parts.

The tabular summaries below and the Tables XIV to XVII of the Appendix give us a picture of the composition of the English landings from the whole North Sea, derived from the mixed series of measurements for each single year of the period and for all three years together. The Tables with the measurement series contain: the absolute and the relative (per million) numbers for each cm. of length and the summation series formed from the relative values, further, for each cm. of length the absolute and relative weight in kg. calculated from $k = 1$ and the summation series formed from the relative weights. For each of the four yearly series the deciles, quartiles, median and vigintiles have been calculated, as well as the arithmetic average, both for the number series and the weight series. Lastly, figs. 24 to 27 give a graphic picture of the number and weight curves for all four yearly groups.

We may consider the three yearly series in succession and lastly, the series representing the sum of the three years. Before the discussion of each series a tabular summary shows the proportion of the measurements to the total landings in all English ports from the North Sea.

Ist year. October 1905/06.

The English landings and measurements from the North Sea in this year are shown in the following Table.

	large	medium	small	size not distinguished	Totals
	kg.	kg.	kg.	kg.	kg.
landed	9,577,046	7,129,474	9,216,873	1,737,665	27,661,058
%	34.62	25.78	33.32	6.28	100.00

	large	medium	small	size not distinguished	Totals
	kg.	kg.	kg.	kg.	kg.
measured	64,284	60,827	128,230	76,577	329,918
%	19.39	18.48	38.80	23.33	100.00
	nos.	nos.	nos.	nos	nos.
	149,147	169,725	843,694	389,384	1,551,950
%	9.60	10.95	54.39	25.06	100.00
	20.55		79.45		

Average weight of the plaice measured.

	kg.	kg.	kg.	kg.	kg.
a. classes distinguished	0.431	0.352	0.152	0,197	—
b. classes not distinguished	—	—	—	—	0.213

Estimated total number of plaice landed.

	large	medium	small	size not distinguished	Totals
a. classes distinguished	22,220,524	20,083,733	60,637,322	8,820,635	111,762,214
					Average weight kg. 0.249.
%	19.90	17.96	54.25	7.89	100.00
	37.86		62.14		
b. classes not distinguished					129,864,122

Appendix Table XIV shows the various groupings of the measurement series for this year. The number 1,552,572 plaice given in the Table differs from MASTERMAN's result 1,551,950 plaice by 622. This difference is due to errors in extracting and summing up the different market-classes; it amounts, however, to only 0.04 % of the total number.

It will at once be seen, that the measurement series does not agree well with the landings in the proportions of the market-classes by weight and number; it is obvious, that far too few small and far too many large plaice have been measured. If, as indicated here, we combine large with medium and small with size not distinguished, we obtain two groups which by weight have the proportion 60 : 40 in the landings, 38 : 62 in the measurements; by number the proportions are 38 : 62 in the landings, 21 : 79 in the measurements. The total number calculated directly from the measurements amounts to 130 million plaice in round numbers with an average weight of 213 gm.,

but the probable number is 112 millions in round numbers with an average weight of 249 gm. By means of these proportions we are able to correct the single and principal values (m) of the summation series to obtain their probable values (w).

October 1905/06. a. *Principal values of the measurement series.*

	Ext.	D	Q	M	Q	D	V	Ext.	Average A
									cm.
Number series . . . . . m	15	21.48	23.37	25.94	29.46	33.56	35.74	69	27.04
— . . . . . w	15	21.94	24.07	27.62	32.16	36.25	39.81	69	28.78
									kg.
Weight series . . . . . m	—	23.08	25.41	29.05	34.01	40.80	45.62	—	e 0.213 b 0.220
— . . . . . w	—	24.03	27.35	32.41	37.29	44.28	48.37	—	0.249

b. *Summation values.*

below	20 cm.	23 cm.	25 cm.	26 cm.	29 cm.	31 cm.	36 cm.	50 cm.
Number series m	3 %	—21 %	—41 %	—51 %	—73 %	—82 %	—94 %	—99.7 %
— — w	2 -	—16 -	—32 -	—40 -	—57 -	—67 -	—89 -	—99.5 -
Weight series m	0.9 %	—10 %	—22 %	—29 %	—50 %	—61 %	—81 %	—97.6 %
— — w	0.6 -	— 6 -	—14 -	—19 -	—32 -	—39 -	—70 -	—96.2 -

It will be seen, that the principal and summation values have also been calculated here for the weight series. For this series $M = 29.05$ means, that 50 % of the (calculated) weight of all plaice of the measurement series lie above and below a length of 29.05 cm and similarly for the other principal values. Again, 50 % of the total weight of all plaice lie between 25.41 and 34.01 cm. — the predominant range of the weight. It is easily understood, why the principal values of the weight series are higher than those of the number series, whilst in the summation series the reverse is the case. The correction of the measurement series with reference to the total landings changes all values very considerably; the principal values become greater, the summation values smaller.

The arithmetic average of the series (A), that is, the average length of all plaice measured, is 27.04 cm., i. e. larger than the median $C(M)$; the probable value A cannot be determined directly but only approximately from its relation to the central value and is found to be about 28.78 cm. The arithmetic average of the weight series (A), that is, the average calculated weight (b) of all plaice measured, is 0.220 kg., the empirical average (e) obtained from the English market-measurements is 0.213 kg., its probable value 0.249 kg.

The calculation, restricted to the landings of the ichthyometric ports Grimsby,

Lowestoft and Boston, which is given by MASTERMAN (104) for the year 1905/06, shows an estimated total number of 81,216,946 plaice with a weight of 21,216,206 kg. and an average weight of 0.261 kg.; the following are the summation values:

1905/06. MASTERMAN.

below	20 cm.	— 23 cm.	— 26 cm.	— 29 cm.
Number series . .	2 %	— 18 %	— 44 %	— 65 %
Weight series . . .	0.5 %	— 7 %	— 21 %	— 38 %

These values lie between the *m* and *w* values calculated by me; they are lower than the former, but higher than the latter. The former result was to be expected. That they are at the same time higher than my *w* values is remarkable, as the latter have been corrected with reference to all landings, including the London market with its many small plaice. Further remarkable also is the high average weight of 261 gm., as calculated by MASTERMAN, by comparison with the smaller, probable value of 249 gm. calculated by me. The very low value of the latter is probably due to the fact, that it has been calculated by means of the averages of the different market-classes obtained directly from the measurements and that the average weight found in this way for the class "large" of only 431 gm. is abnormally low, as the great majority of the "large" measured in 1905/06 were landed in Lowestoft. In the other two years the average weight of the "large" is 601 and 664 gm. This seriously discounts the representative value of the yearly series 1905/06 and also of the corrected series.

IInd Year. October 1906/07.

The English landings and market-measurements for this year are shown in the following Table.

	large	medium	small	unsorted	Totals
	kg.	kg.	kg.	kg.	k.
landed	8,625,027	7,194,804	12,964,414	1,996,468	30,750,713
%	28.05	23,40	42.16	6.39	100.00
	kg.	kg.	kg.	kg.	kg.
measured	164,674	93,411	171,403	39,850	469,347
%	35.18	19.83	35.46	8.53	100.00
	nos.	nos.	nos	nos.	nos.
	273,985	257,449	999,336	246,322	1,777,092
%	15.41	14.48	56,24	13,87	
	29.89		70.11		

Average weight of the plaice measured.

	kg.	kg.	kg.	kg.	kg.
a. classes distinguished . . .	0.601	0.363	0.172	0.162	—
b. classes not distinguished .	—	—	—	—	0.264

Estimated total number of plaice landed.

a. classes distinguished . . .	14,351,126	19,820,397	75,374,500	12,323,876	121,869,899
%	11.78	16.26	61.85	10.11	100.00
	28.04		71.96		
					Average weight kg. 0.252
b. classes not distinguished .	—	—	—	—	116,479,973

In sharp contrast to the year 1905/06 the measurement series of this year 1906/07 is to be regarded as very satisfactorily representative, as can be seen at the first glance. The proportions of all market-classes agree well in the landings and measurements both by weight and number, we may even say *very well.* The proportion of large+medium to small+size not distinguished is by weight in the landings 51.45 : 48.55, in the measurements 55 : 45; by number in the landings 28 : 72, in the measurements 30 : 70. Thus, somewhat too few small plaice have been measured.

1906/07. a. *Principal values of the summation series.*

	Ext.	D	Q	M	Q	D	V	Ext.	Average values A
									cm.
Number series . . . . *m*	17	22.28	24.15	26.91	30.80	36.14	42.51	76	28.47
— . . . . *w*	17	22.24	24.08	26.74	30.49	35.64	41.72	76	28.29
									kg.
Weight series . . . . . *m*	—	24.05	26.77	31.24	40.30	49.49	53.41	—	e 0.264 b 0.271
— . . . . . *w*	—	23.88	26.40	30.51	39.20	48.95	53.00	—	0.252

b. *Summation values.*

below	20 cm.	23 cm.	25 cm.	26 cm.	29 cm.	31 cm.	36 cm.	50 cm.
Number series *m*	0.9 %	15 %	33 %	43 %	65 %	76 %	90 %	98.4 %
— *w*	0.9 -	15 -	34 -	44 -	67 -	78 -	91 -	98.5 -
Weight series *m*	0.2 %	6 %	15 %	21 %	38 %	49 %	67 %	91 %
— *w*	0.2 -	7 -	16 -	23 -	41 -	53 -	69 -	91.7 -

The arithmetic average of the length series (A), that is the average length of all plaice measured in 1906/07 is 28.47 cm., the probable, calculated from the relation to the median, is approximately 28.29 cm. The *A* of the weight series is 264 gm. determined empirically (e) from the English weighings, 271 gm. obtained theoretically (b) from the calculated weights of the measurement series; the probable value is 252 gm. The estimated *total number* of all English landings for the year October 1906/07, without

regard for the market-classes, is about 116.5 millions, the probable number about 122 millions.

It will be seen, that the correction of the principal and summation values leaves these but little altered. The median (M) and the arithmetic average (A) remain within the limits of half an interval; the greatest change in the summation values amounts to 4 %. MASTERMAN's calculation for the landings of Grimsby, Lowestoft and Boston (105) leads to a total number of 95,169,474 with a total weight of 22,474,481 kg. and an average weight of 236 gm.; the following are the summation values:

below	20 cm.	23 cm.	26 cm.	26 cm.
Number series . .	0,9 %	16 %	46 %	70 %
Weight series . .	0,2 -	6 -	24 -	44 -

They show a good agreement with the values obtained by me, especially the w values, which are, for the length series 0.9—15—44—67 %, and for the weight series 0.2—7—23—41 %. In MASTERMAN's case there are somewhat more small plaice below 29 cm.; correspondingly, the average weight per plaice is smaller (236 gm.) according to MASTERMAN than according to my estimate (252 gm.).

IIIrd Year. October 1907/08.

The English landings and market-measurements from the North Sea for this year are as follows:

	large	medium	small	unsorted	Totals
	kg.	kg.	kg.	kg.	kg.
landed	7,536,281	7,640,930	11,922,862	2,340,204	29,440,277
%	25.60	25.95	40.50	7.95	100.00
	kg.	kg.	kg.	kg.	kg.
measured	115,676	84,197	191,792	24,388	416,053
%	27.87	20.19	46.17	5.77	100.00
	nos.	nos.	nos.	nos.	nos.
	174,214	238,786	1,033,181	149,465	1,595,646
%	10.92	14.98	64.74	9.36	100.00
	25.90		74.10		

Average weight of the plaice measured.

	kg.	kg.	kg.	kg.	kg.
a. classes distinguished . . .	0.664	0.353	0.186	0.163	—
b. classes not distinguished .	—	—	—	—	0.261.

Estimated total number of plaice landed.

a. classes distinguished . . .	11,349,821	21,645,694	64,101,387	14,357,080	111,453,982
					Average weight kg. 0.264
%	10.19	19.42	57.51	12.88	—
	29.61		70.39		
b. classes not distinguished .	—	—	—	—	112,798,000

Like the foregoing, the measurement series of this year may also be considered to have a good representative character. The classes large + medium and small + unsorted stand in the proportion by weight of 52 : 48 in the landings, 48 : 52 in the measurements; by number 30 : 70 in the landings, 26 : 74 in the measurements. Somewhat too many small have been measured.

1907/08. a. *Principal values of the summation series.*

	Extr.	D	Q	M	Q	D	V	Extr.	A
									cm.
Number series . . . *m*	16	22.47	24.43	27.29	31.27	35.72	40.87	71	29.32
— . . . *w*	16	22.57	24.58	27.68	31.98	36.69	42.34	71	29.74
									kg.
Weight series . . . *m*	—	24.26	27.00	31.34	38.00	48.32	52.22	—	e 0.261 b 0.272
— . . . *w*	—	24.43	27.36	32.11	38.98	49.97	52.65	—	0.264

b. *Summation values.*

below	20 cm.	23 cm.	25 cm.	26 cm.	29 cm.	31 cm.	36 cm.	50 cm.
Number-series *m*	0.8 %	13 %	30 %	40 %	62 %	74 %	91 %	98.7 %
— *w*	0.8 %	12 %	28 %	38 %	59 %	70 %	90 %	98.5 %
Weight-series *m*	0.2 %	5 %	14 %	19 %	36 %	48 %	71 %	92 %
— *w*	0.2 %	5 %	13 %	18 %	33 %	44 %	69 %	91 %

The average length (A) of the plaice measured in 1907/08 amounts to 29.32 cm., thus greater than that for 1906/07 (28.47 cm.); through the correction for the total landings the average becomes still greater, approximately 29.74 cm. The theoretical average weight (b) calculated from our mixed series is 272 gm., the empirical average

(e) found from the English measurements is 261 gm.; the probable average calculated for the total landings, having regard for the market-classes, is 264 gm.

MASTERMAN's calculations (106) for the landings of the ichthyometric ports in this year give 96,388,269 plaice with a total weight of 22,625,762 kg. and an average weight of 236 gm.; the following are the summation values:

below	20 cm.	23 cm.	26 cm.	29 cm.
Number	0.8 %	14 %	45 %	69 %
Weight	0.2 %	6 %	23 %	43 %

They do not agree specially well with my values, but more with the *m* values, less with the *w* values. In MASTERMAN's estimates there are rather more small plaice below 29 cm. than in my mixed series and estimates; correspondingly, the average weight is also lower (236 instead of 264 gm.).

Ist—IIIrd year. October 1905/08.

Uniting all the English plaice landings from the North Sea and all the English measurements for the period October 1905/08 we obtain the following Table.

	large	medium	small	unsorted	Total
	kg.	kg.	kg.	kg.	kg.
landed	25,738,354	21,965,208	35,104,149	6,044,337	8.7852,048
%	29.30	25.00	38.82	6.88	100.00
	kg.	kg.	kg.	kg.	kg.
measured	344,634	238,435	491,425	140,824	1,215,318
%	28.39	19.59	40.41	11.61	100.00
	nos.	nos.	nos.	nos.	nos.
	597,346	665,960	2,876,211	785,171	4,924,688
%	12.13	13.53	58.40	15.94	100.00
	25.66		74.34		

Average weight of the plaice measured.

	kg.	kg.	kg.	kg.	kg.
a. classes distinguished	0.577	0.358	0.171	0.179	—
b. total	—	—	—	—	0.247

Estimated total number of plaice landed.

	kg.	kg.	kg.	kg.	kg.
a. classes distinguished	44,607,200	61,355,330	199,439,468	33,767,246	339,169,244
%	13.15	18.09	58.82	9.94	—
	31.24		68.76		
					Average weight kg. 0.259
b. classed not distinguished .	—	—	—	—	355,684,405

As was to be expected, the representative value of my three years' series given in Appendix Table XVII is not so great as that of the year 1906/07, but greater than that of the year 1905/06; otherwise, however, it may be regarded as fairly satisfactory, The proportion of the large+medium to the small+unsorted is by weight 54 : 46 in the landings, 49 : 51 in the measurements; by number 31 : 69 in the landings, 26 : 74 in the measurements; thus somewhat too many small have been measured. The proportions are almost the same as in the year 1907/08.

1905/08. a. *Principal values of the summation series.*

	Extr.	D	Q	M	Q	D	V	Extr.	A
									cm.
Number series . . *m*	15	22.10	23.98	26.70	30.57	35.13	39.74	76	28.08
— . . *w*	15	22.20	24.17	27.16	31.43	36.14	41.42	76	28.19
Weight series . . *m*	—	23.79	26.41	30.65	37.30	47.47	51.65	—	kg. {e. 0.247 b. 0.255
— . . *w*	—	23.94	26.67	31.15	38.25	48.04	52.05	—	0.259

b. *Summation values.*

	below 20 cm.	— 23 cm.	— 25 cm.	— 26 cm.	— 29 cm.	— 31 cm.	— 36 cm.	— 50 cm.
Number series *m*	1.5 %	— 17 %	— 35 %	— 44 %	— 66 %	— 77 %	— 91 %	— 98.9 %
— *w*	1.4 %	— 16 %	— 33 %	— 41 %	— 62 %	— 75 %	— 89 %	— 98.7 %
Weight series *m*	0.4 %	— 7 %	— 16 %	— 23 %	— 40 %	— 52 %	— 72 %	— 93.2 %
— *w*	0.4 %	— 7 %	— 16 %	— 22 %	— 38 %	— 49 %	— 69 %	— 92.8 %

The arithmetic average (A) of the lengths of all plaice measured is 28.08 cm., the probable average for the plaice landed approximately 28.19 cm. The theoretical average weight (b) calculated from my mixed series is 255 gm., the empirical (e) from the English measurements and weighings 247 gm., the probable of the landings 259 gm.

MASTERMAN's calculations (107) for the landings in the three ichthyometric ports Grimsby, Lowestoft and Boston during the period 1905/08 give an estimated total

number of 272,774,689 plaice with a total weight of 66,316,449 kg. and an average weight per plaice of 243 gm.; the following are the summary values.

below	20 cm.	23 cm.	26 cm.	29 cm.
Number	1.2 %	16 %	45 %	68 %
Weight	0.3 %	6 %	23 %	42 %

These values are in *very good* agreement with my *m* values (at most 2 % difference), a proof that my mixed series for the three years 1905/08 for the landings of the ichthyometric ports has a very high representative value. The combination of the measurements of all three years has thus in fact smoothed out many incongruences in the selection of the market-samples.

Comparison of the different years.

We may now examine, how far my mixed series for the three years and for the sum of the three years differ from one another in their composition, how far each is representative for the landings of the year in question, and to which series the highest representative value may be ascribed, that is, which gives us the most accurate and reliable picture of the English landings from the North Sea.

To throw light on these questions I give here (1) a comparative summary of the principal and summation values of the 4 series; the series for the three years combined (1905/08) — expressed in relative numbers — may without essential error be regarded as the average of the three other series, since the absolute numbers of the plaice measured in each single year differ very little from their average. (2) Graphic representations of the 4 series as percentage curves, both number and weight curve in kg. for each year. (3) Under each 5 cm. of the abscissa of the curves the average age in years is indicated, which the plaice of the lengths mentioned possess (males and females together). These data have been calculated by me from the available international age-determinations, for the lengths from 20 to 35 cm. from the annual rings on the otoliths, for the lengths from 40 to 65 cm. from the annual rings on the bones.

Table 21. *English Market-Measurements.* Comparison of the composition of the landings in the different years by means of the principal and summation values.

m (heavy type) values calculated from the mixed series of measurements; *w* (ordinary type) values calculated with reference to the total landings; *M* (italics) values calculated by MASTERMAN for the landings of the three ichthyometric ports. The weights with an * have been calculated theoretically by means of the formula $w = \frac{l^3 \cdot k}{100}$, where $k = 1$.

Year	Total landings			Principal values of the measurement series				Summation values			
	Total million kg.	% of market-classes			A. Average		Median	% of total (weight) below			
		large + medium	small + unsorted		cm.	gm.	cm.	20 cm.	23 cm.	26 cm.	29 cm.
I. 1905/06	27.7	34 + 26 = 60	34 + 6 = 40	No.							
				m	**27.0**	—	**25.9**	**3**	**21**	**51**	**73**
				w	—	—	27.6	2	16	40	57
				M	—	—	—	*2*	*18*	*44*	*65*
				Weight							
				m	—	*b **220** e **213**	**29.0**	**0.9**	**10**	**29**	**50**
				w	—	249	32.4	0.6	6	19	32
				M	—	*261*	—	*0.5*	*7*	*21*	*38*
II. 1906/07	30.7	28 + 23 = 51	42 + 7 = 49	No.							
				m	**28.5**	—	**26.9**	**0.9**	**15**	**43**	**65**
				w	—	—	26.7	0.9	15	44	67
				M	—	—	—	*0.9*	*16*	*46*	*70*
				Weight							
				m	—	*b **271** e **264**	**31.2**	**0.2**	**6**	**21**	**38**
				w	—	252	30.5	0.2	7	23	41
				M	—	*236*	—	*0.2*	*6*	*24*	*44*
III. 1907/08	29.4	26 + 26 = 52	40 + 8 = 48	No.							
				m	**29.3**	—	**27.3**	**0.8**	**13**	**40**	**62**
				w	—	—	27.7	0.8	12	38	59
				M	—	—	—	*0.8*	*14*	*45*	*69*
				Weight							
				m	—	*b **272** e **261**	**31.3**	**0.2**	**5**	**19**	**36**
				w	—	264	32.1	0.2	5	18	33
				M	—	*236*	—	*0.2*	*6*	*23*	*43*
I—III. 1905/08 Average of the 3 years	29.3	29 + 25 = 54	39 + 7 = 46	No.							
				m	**28.1**	—	**26.7**	**1.5**	**17**	**44**	**66**
				w	—	—	27.2	1.4	16	41	62
				M	—	—	—	*1.2*	*16*	*45*	*68*
				Weight							
				m	—	*b **255** e **247**	**30.6**	**0.4**	**7**	**23**	**40**
				w	—	259	31.1	0.4	7	22	38
				M	—	*243*	—	*0.3*	*6*	*23*	*42*

This comparison of the series for the different years shows, in the first place, that the mixed series of the first year 1905/06 has *the lowest representative value*. The summation values calculated from it agree very badly with those given by MASTERMAN.

Even by comparison with the total landings of all ports, including London, far too many small plaice are contained in the series; all its values require a considerable correction, therefore, to make them to some extent trustworthy. Thus, if the principal values of the series, e. g. the arithmetic average and the median, are very low (27.0 and 25.9 cm.)

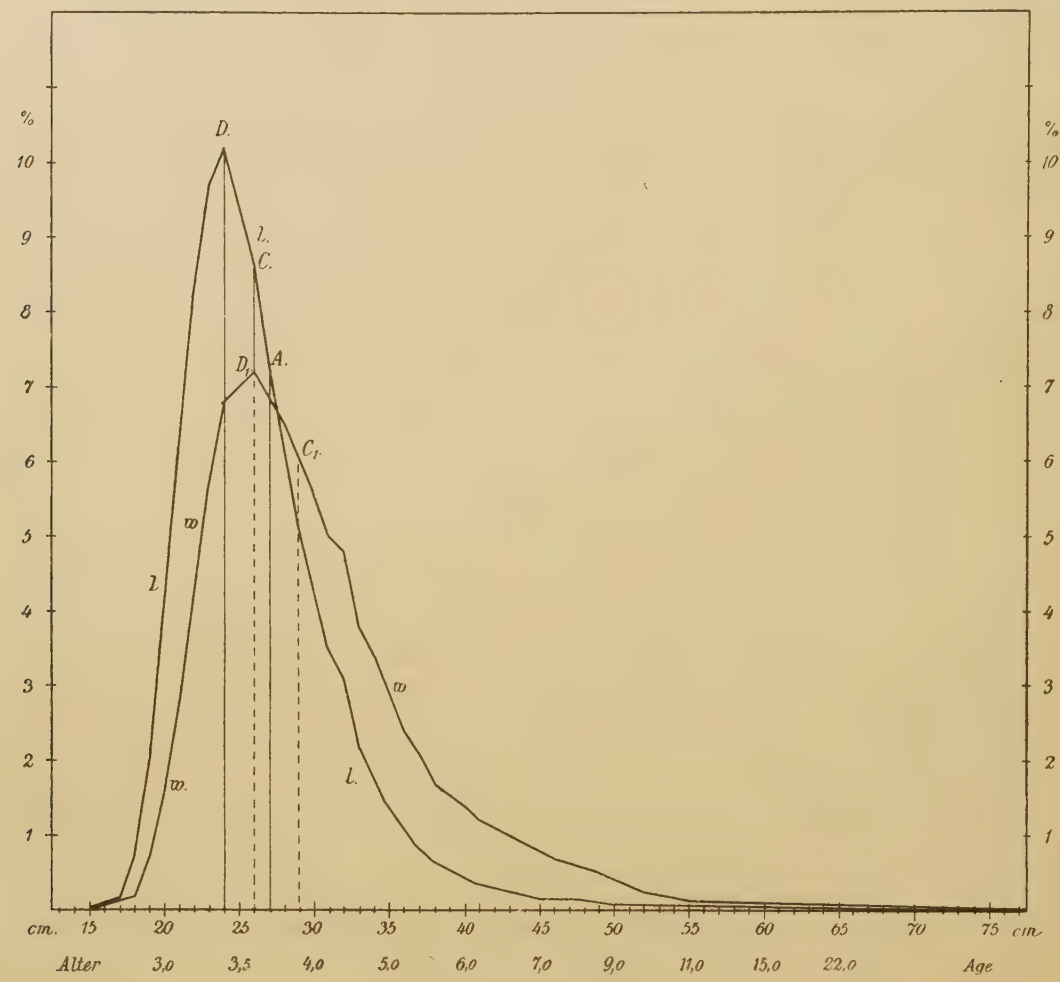


Fig. 24. *English Market-Measurements.* Ist Year, October 1905/06. Analysis by length and weight of all plaice measured in English ports (1,552,572). The length curve (l) gives the number at each cm. of length; the weight curve (w) the weight (in kg.) of the number of plaice at each length. — Percentage curves.
D Mode, C Median, A Arithmetic average of l
D_1 — C_1 — . . . . . of w

and seem to indicate at first glance, that the plaice landings of the year 1905/06 contained on an average considerably smaller plaice than those of the other two years, such an assumption must in any case be considered unfounded. The correction necessary rather shows, that no such difference existed in reality between this year and the others. For example, the median is shifted by the correction from 25.9 to 27.6 cm., that is,

it approximates to the corresponding values of the other two years, especially to that of the third year, and so much so, that an essential agreement of the first with the other years becomes much more probable than a difference. A correction of the 1905/06 series for all the single, principal and summation values would thus, in all probability,

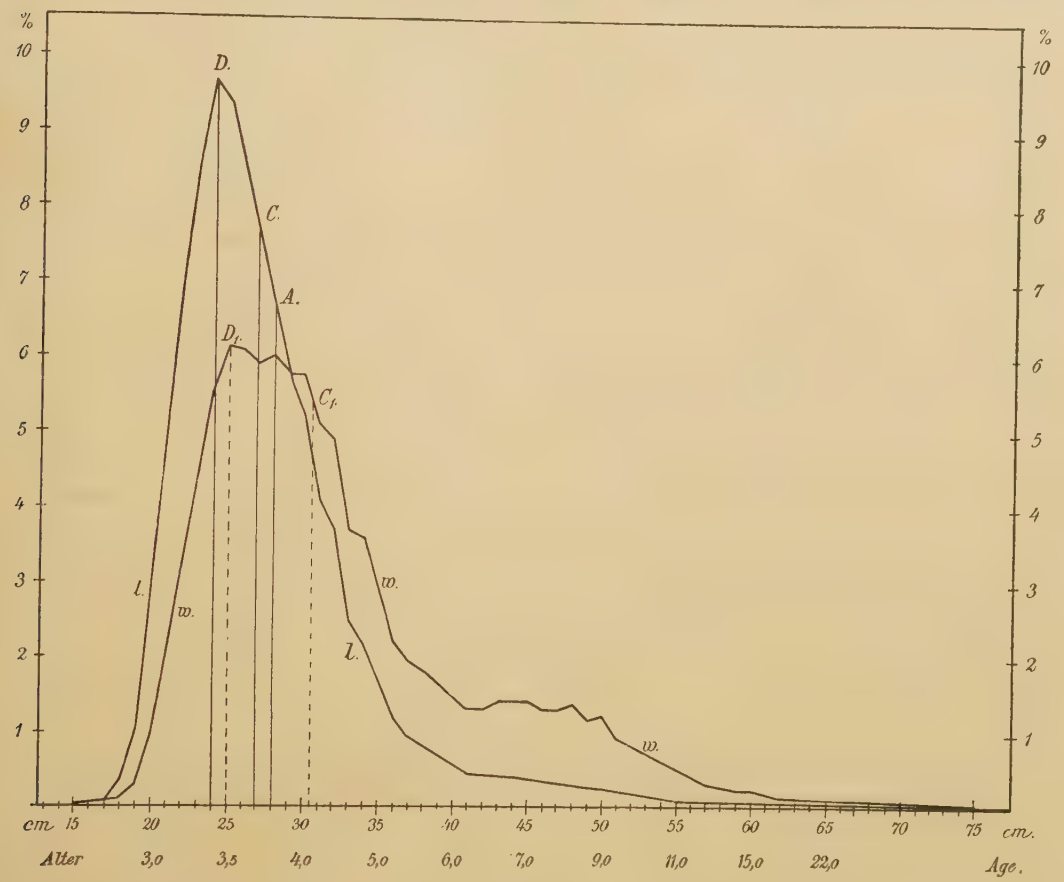


Fig. 25. *English Market-Measurements.* IInd Year, October 1906/07. Analysis by length and weight of all plaice measured in English ports (1,775,658). *l* length curve; *w* weight curve. — Percentage curves.
D Mode, C Median, A Arithmetic average of *l*
D_1 — C_1 — . . . . . of *w*

give a series quite similar to those of the other years. As our method of correcting can only give approximate values, however, it is better to dispense with such a total correction and reject the series as useless for a reliable statement of the composition of the landings.

In contrast to the first year, the measurement series of the *second year* 1906/07 has a very high representative value, as is seen both from the very small degree of correction necessary with reference to the total landings and from the very good agreement of the summation values with the estimates given by MASTERMAN.

The same applies to the third year 1907/08.

The series constructed as the sum of the three years 1905/08 shows in its summation values the best agreement with MASTERMAN's calculations. The correction necessary with reference to the total landings of all ports is certainly somewhat greater than in the case of the years 1906/07 and 1907/08, but yet comparatively small. This

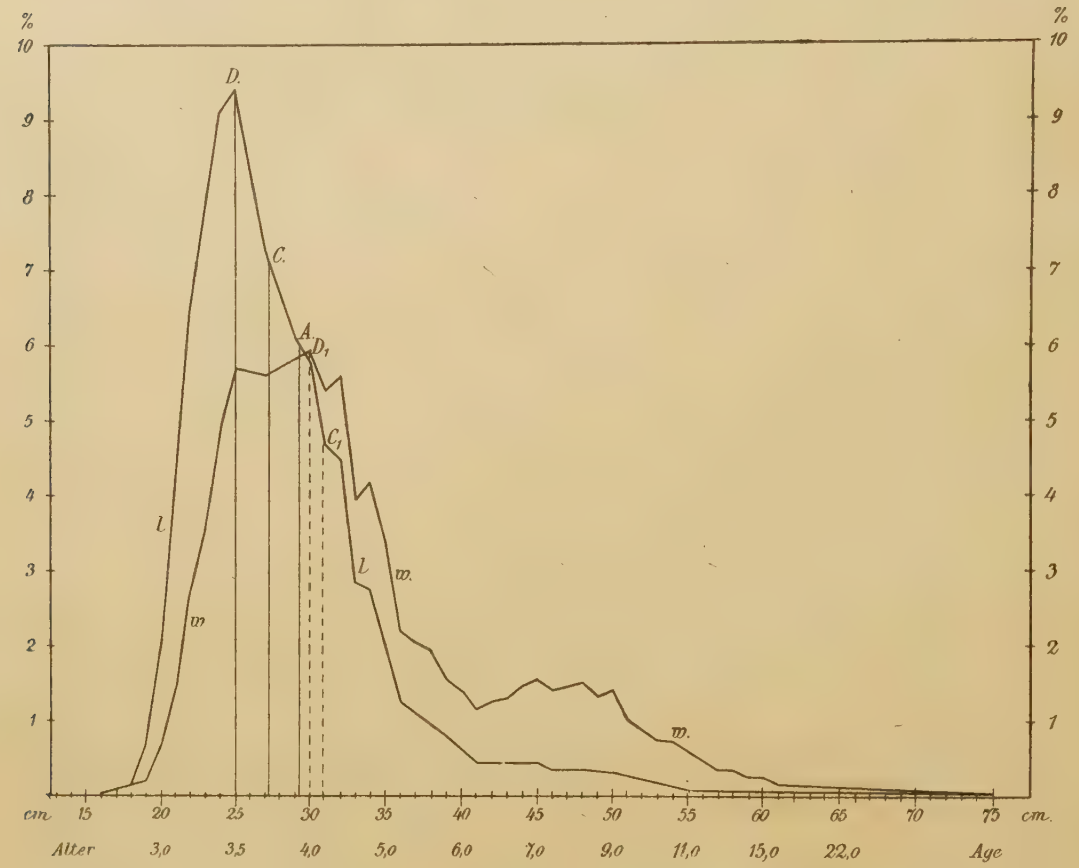


Fig. 26. *English Market-Measurements.* IIIrd Year, October 1907/08. Analysis by length and weight of all plaice measured in English ports (1,597,468). *l* length curve; *w* weight curve. — Percentage curves.
D Mode, C Median, A Arithmetic average of *l*
D_1 — C_1 — . . . . . of *w*

is a proof, that the combination of the three yearly series into one, has greatly smoothed out the abnormal values of the year 1905/06 and the smaller differences of the years 1906/07 and 1907/08. The median at 26.7 cm. stands very closely to that of the second year (26.9 cm.) and is only half a centimetre lower than that of the third year. The summation values of the numbers are correspondingly somewhat higher than those of the last two years, especially of the third, yet not so very much, at most 4 %.

Thus, a satisfactory representative value is also to be ascribed to the average for the three years.

If we calculate the *averages* for the principal and summation values of the two yearly series II and III on the one hand and of the three series II, III and I—III on the other, we obtain almost the same result in both cases; for example, for the median of the numbers 27.1 and 27.0 cm., for the summation values of the numbers at 23, 26

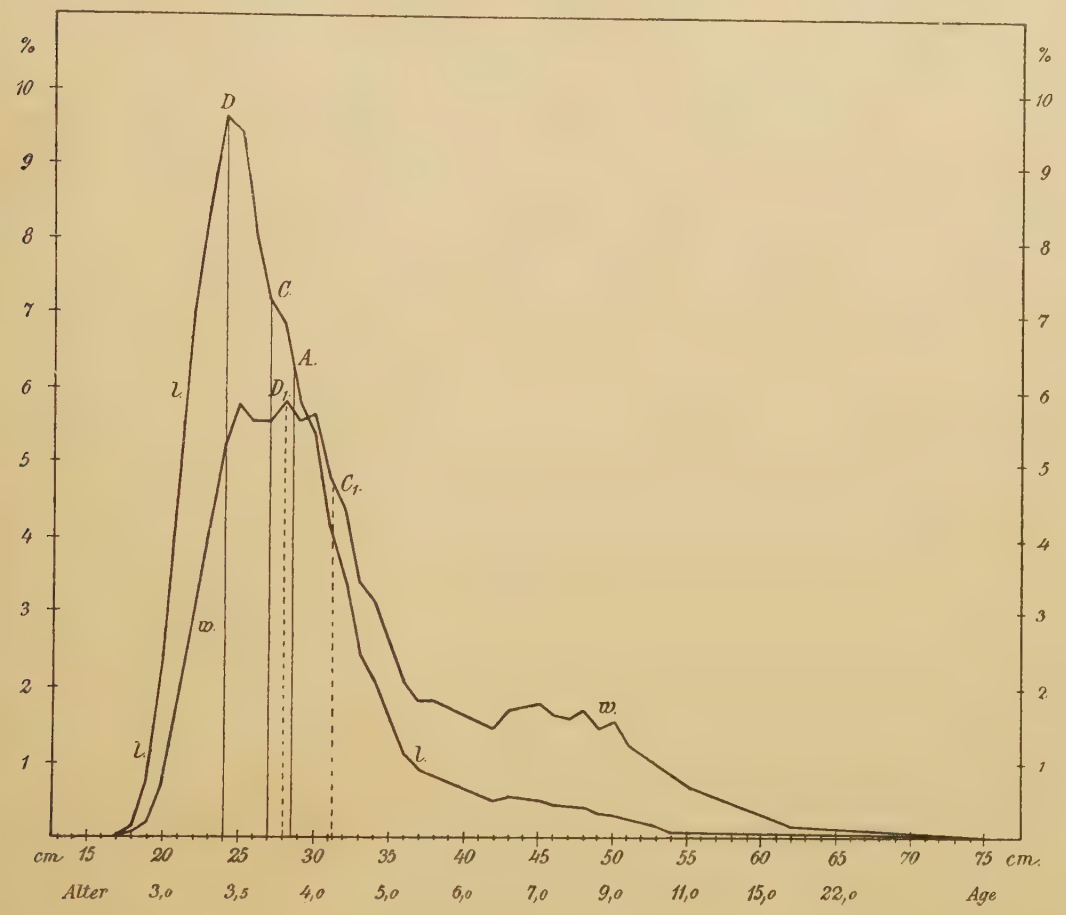


Fig. 27. *English Market-Measurements.* Ist—IIIrd Year, October 1905/08. Analysis by length and weight of all plaice measured in English ports (4,925,698). *l* length curve; *w* weight curve. — Percentage curves.
D Mode, C Median, A Arithmetic average of *l*
D_1 — C_1 — . . . . . of *w*

and 29 cm. 14 %, 42 %, 64 % and 15 %, 42 %, 64 %; for the corresponding values of the weight series 31.2 and 31.0 cm., as also 6 %, 20 %, 37 % and 6 %, 21 %, 38 %. If we make the same calculation for the *w* values corrected with reference to the total landings, we obtain results which agree with the average *m* values almost completely. Thus, from our measurement series, with exception of 1905/06, we obtain the most reliable representative values when we take the average values of the years 1906/07 and 1907/08 or of these two and the three years' period 1905/08.

We may enquire again, whether the differences between the most representative series 1906/07 and 1907/08 are so great, that we can conclude from them, that *an actual difference has existed in the composition of the landings of these two years.* As Table 21 shows, these two years are extremely similar in regard to the amount of the total landings and the percentage composition by weight; we should therefore expect no essential difference in their composition as regards size. Nevertheless, our two mixed series for these years show such a difference. The plaice of 1907/08 have a greater average length than those of 1906/07, namely 29.3 against 28.5 cm., and this difference in size is also shown correspondingly in the median values (27.3 against 26.9 cm.) and in the summation values of the number series, both in the *w* and *m* values. MASTERMAN's calculations also give similar, though smaller differences. On the other hand, the theoretical average weights of the two series are remarkably alike 272 and 271 gm., and also the median values of the weight series. If, now, we calculate the theoretical probable error of the two medians in the number series, for example, we obtain according to the method indicated above p. 52, C = 26.91 $\pm$ 0.0031 for 1906/07 and C = 27.29 $\pm$ 0.0036 for 1907/08, errors which, referred to the total landings and not only to the numbers measured, become reduced to $\pm$ 0.00305 and $\pm$ 0.00355. Taking five times the probable error, we may conclude that, if subject only to chance and to a similar mixing in both series, then the median value of 1906/07 must in all cases lie between 26.88 and 26.93 cm., that of 1907/08 between 27.27 and 27.31 cm. As there is still the large gap of 0.30 cm. between these two ranges of variation, there must be another factor apart from pure chance determining the difference in the values. This may be, either an actual difference in the size of the plaice and the composition of the landings of the two years, or an insufficient mixing of the samples measured, of the one or other year. We thus see, that the change which the median may experience from insufficient mixing of the samples measured, is considerable, that is, almost as great as the difference between the *m* value and the corrected *w* value for a right mixture; for example, in the year 1906/07 from 26.9 to 26.7 and in 1907/08 from 27.3 to 27.7. These changes naturally may result in a fall or rise of the median, just as the correction leads to a reduction in the IInd year, an increase of the median in the IIIrd year. In consequence of insufficient mixing, therefore, the value C (M) may thus vary considerably; in the case of 1906/07 at least within the limits 26.7 to 27.1 and for 1907/08 at least within the limits 26.9 to 27.7 cm. It will be seen, that the ranges of variation for the two years overlap one another considerably. It is thus fairly clear, that our series of measurements, in consequence of imperfect mixing of the samples measured, possess an uncertainty in the single, principal and summation values which is very probably much greater than the difference in these values actually calculated from the series. The result is, therefore, that *no proof is forthcoming for an actual difference between the two years considered;* though the possibility of such a difference cannot be dismissed, it is yet little probable. It is thus preferable to make use of the averages of the two years.

If we compare the curves for the four yearly series, represented as percentage curves in figs. 24 to 27, we at once note the great agreement between the series 1906/07, 1907/08 and 1905/08, by contrast with the curve for 1905/06, which shows a distinctly different character.

The valuable *conclusion to be drawn* from these investigations on the composition of the English plaice landings from the North Sea is, that our measurement series for the years 1906/07, 1907/08 and 1905/08, especially the first two and their averages, give us a picture of that composition, which, in spite of the numerous, unavoidable errors in such investigations, must be regarded as sufficiently *reliable and trustworthy*. That this is the case, is due in the first instance to the fact, that the English market-measurements were made systematically and in very large number in all months of the year and from all areas during the years October 1906/08. For our practical purposes, the determination of an international size-limit for the plaice and estimation of its effects on the product of the plaice fishery, this is a gain which can scarcely be valued too highly, since the English plaice landings alone compose by weight more than 60 % of all landings from the North Sea (see p. 62) and at the same time come from all parts of the North Sea. Their composition will, therefore, probably be representative in essentials of all landings from the whole North Sea or require but a relatively small correction in order to be so.

The following brief *summary of the composition of the plaice landings* of first-class English vessels from the North Sea in the years October 1905/08 deals mostly with the average values for the two series 1906/07 and 1907/08 (Appendix Tables XV and XVI, Figs. 25 and 26).

The average yearly landings by weight amount to 29 million kg., by number 112.5 million plaice from 15 to 76 cm. in length and from 37 to 4477 gm. in weight. The average length of all plaice landed is about 29 cm., the average weight calculated empirically (from weighings of partly cleaned, partly entire fish) 258 gm., calculated theoretically ($k = 1$) 271 gm.; the former is 0.952 of the latter.

The interval with the highest number of specimens (mode or D) is 25 cm. The part of the series below this length (ascending arm of the curve) is subject to a market-selection; that is, of the small plaice actually caught up to a length of 24 cm. not the whole catch but only a portion is landed; on the other hand — apart from chance loss — all the plaice caught above 25 cm. in length are brought to market. The plaice only partly landed up to and including those at 24 cm. in length, which we may conveniently call "undersized" plaice, have an average age of 2, 3 to $3^1/_2$ years. The quantities of these brought to market compose about $^1/_3$rd (32 %) of the number and about $^1/_7$th (14 %) of the weight of the total landings. The percentage of undersized plaice discarded by the market-selection increases, the smaller the plaice are and in a very rapid manner. Thus, the plaice below 23 cm. (up to and including 22 cm.) compose only 14 % by number, only 5 % by weight of the landings, those below 20 cm. (up to and including 19 cm.) only 1 % and 0.2 %; those below 18 cm. only 0.01 % by number and 0.0015 % by weight of all landings. 18 cm. is the size-limit used consciously in practice, though not imposed by law, and we can see how the first-class vessels keep well above it. Of the 112.5 million plaice landed only 11,250 approximately are below this size-limit. The plaice below 29 cm. in length have been called here generally "small" plaice; this has been done, after examination had shown, that the quantities of these plaice by number and weight in our measurement series (about 63 % and 40 %) agree well with the corresponding quantities in the landings; though the market-class "small" admittedly contains a number of plaice which are larger than

28 cm., yet their number is fairly well counterbalanced by the number of plaice below 29 cm., which are included in the market-class "medium". In the same way, we may call the plaice over 35 cm. "large", the plaice between 29 and 35 cm. in length thus forming the group "medium". The proportions of these three groups small, medium and large are, by number, 63 : 27 : 10; by weight 37 : 32 : 31; or, again, by number 7 : 3 : 1; by weight almost 1 : 1 : 1. The "small" plaice are on an average 2 to 4 years old, the "medium" 4 to 5 years, the "large" 5 to 25 and more years. Among the small plaice almost all the males, but very few females are mature; among the medium all the males and about 1/3rd of the females, among the large almost all the females also.

The length above and below which 50 % of the number of all plaice in the English landings lie, i. e. the *central or median value of the number series*, is 27 cm. The two lengths, between which half the number of all plaice lie, i. e. the two quartiles, are 24 and 31 cm. This interval is thus the predominant range of the series; it contains plaice at an average age of 3½ to 4 years; 10 % of these are undersized, 40 % small and 10 % medium plaice.

The length, above and below which 50 % of all the plaice by weight lie, i. e. the median or central value of the *weight series*, is 31 cm.; the corresponding quartiles about 26.5 and 38.5 cm.; between these lie 50 % of all plaice by weight; they form the predominant range of the weight series, including about 15 % of small, 30 % of medium and 5 % of large.

The *number of plaice* decreases very rapidly with the size and age, counting from the mode or greatest frequency of the series. The large plaice especially, over 50 cm. and more than 9 years old on an average are very scarce; by number they compose only 1 % and by weight only about 7 % of the total amount of the landings. An even clearer picture of this decrease is obtained, if we only consider the plaice from 25 cm. onwards in our measurement series and take their total number as 1 million. Then the number of plaice at the different lengths from 5 to 5 cm. is as follows.

In 1 million plaice of 25 to 70 cm. in length and over there are in round numbers:

Length in cm.	25	30	35	40	45	50
No. of spec.	140,000	81,000	26,000	9,000	7,000	4,000
Average age (rounded)	3.5	4.0	5.0	6.0	7.0	9.0
Percentage decrease from 5 to 5 cm.	42 %	68 %	65 %	23 %	43 %	62 %

Length in cm.	55	60	65	70
No. of spec.	1,500	500	90	15
Average age (rounded)	11.0	15.0	22.0	—
Percentage decrease from 5 to 5 cm.	67 %	82 %	83 %	

We see here the very important fact, that the decrease in the number of plaice from 5 to 5 cm. is very rapid but at the same time very unequal at the different sizes and ages. From 25 to 30 cm., when the plaice have an average age of 3.5 to 4 years, their number in the landings decreases from about 140,000 to about 81,000, i. e. by

42 %, and approximately the same amount (43 %) from 45 to 50 cm., when the plaice are from 7 to 9 years old. In the case of plaice from 30 to 35 cm., in their fifth year, the percentage decrease in number is on the other hand very much greater, namely 68 %, and almost as great in the case of plaice in the sixth year from 35 to 40 cm. and those from 50 to 55 cm. (9th to 11th year) and from 55 to 60 cm. (12th to 15th year). Still greater, lastly, is the percentage decrease in the number of plaice from 60 to 65 cm. and from 65 to 70 cm., namely, 83 % for plaice from the 16th to 22nd year and still older. Least of all, only 23 %, is the decrease from 40 to 45 cm., i. e. in the case of plaice of the seventh year.

If we compare the percentage decrease in the number of plaice in the course of each year with the average growth in the same year, we obtain the following results from our age-determinations, represented graphically in the figs. 24 to 27. In these the percentage decrease in the number of plaice in the fourth year from 20 to 30 cm. is only to be seen for the second half of this year from our analysis of the landings, for the first half it has been obtained from the analysis of the scientific samples; from these two the whole decrease from 20 to 30 cm. has been calculated.

Year	4	5	6	7
Length	(20—30 cm.)	30—35 cm.)	(35—40 cm.)	(40—45 cm.)
Average growth in length per year . . . . . cm.	10	5	5	5
Percentage decrease in number per year	77 %	68 %	65 %	23 %

Year	8, 9	10, 11	12, 13, 14, 15	16, 22
Length	(45—50 cm.)	(50—55 cm.)	(55—60 cm.)	(60—65 cm.)
Average growth in length per year . . . . cm.	5	2.5	1.2	0.7
Percentage decrease in number per year	21 %	31 %	18 %	12 %

It will be seen from these results, which, however, are only to be taken as approximate, that the percentage decrease in number of plaice in the course of each year is greater, when the average, annual growth in length is greater. There is a remarkable exception, however, in the 5th and 6th years on the one hand and in the 10 and 11th on the other, or the sizes from 30 to 40 cm. and from 50 to 60 cm.; in these the percentage decrease in the number of plaice is greater than it should be in proportion to the number of plaice.

If we change the number series of the plaice into a logarithmic series, taking instead of the absolute numbers at each length the logarithm (see p. 57), then, as is well-known, an equal decrease in the logarithm corresponds to an equal, percentage increase or decrease in the number of specimens. This has been done in Appendix Table XV for our year's series 1906/07. We then have the following series:

Length in cm.	25	30	35	40	45
Log. of the number	5.224	4.984	4.439	4.057	3.953
Difference		0.240	0.545	0.382	0.104	0.192

Length in cm.	50	55	60	65	70
Log. of the number	3.761	3.291	2.824	1.982	1.204
Difference		0.470	0.467	0.842	0.778

The high value of the logarithmic differences between 30 and 35 cm. and 35 and 40 cm. by contrast with the smaller value between 40 and 50 cm. is noticed at once.

In addition to the percentage decrease in number of plaice by size and age it is also of interest to investigate the corresponding decrease in the weight, and to compare the two together. The series p. 148 may then be completed in the following manner.

In 1,000,000 plaice from 25 cm. onwards we have:

Length in cm.	25	30	35	40	45
Average age	3.5	4	5	6	7
Number	140,000	81,000	26,000	9,000	7,000
Percentage decrease of nos.		42 %	68 %	65 %	23 %	43 %
Calcul. weight in kg. (rounded)	23,000	23,000	11,500	6,000	6,600
Percentage decrease of weight		0 %	50 %	48 %	0 %	17 %

Length in cm.	50	55	60	65	70
Average age	9	11	15	22	—
Number	4,000	1,500	500	90	15
Percentage decrease of nos.		62 %	67 %	82 %	83 %
Calcul. weight in kg. (rounded)	5,000	2,600	1,100	250	55
Percentage decrease of weight		48 %	58 %	77 %	78 %

The result of this comparison of the decrease in numbers with the decrease in weight is readily understood in so far as the decrease in numbers is always greater than the decrease in weight at the same stage; for the weight of a plaice increases proportionally to the third power of the length, with the consequence, that the decrease in numbers with increasing length is partially compensated for by the increase in weight of the single plaice. A surprising result is, however, that this compensation is so considerable at certain stages, that *there is no decrease at all in the weight,* perhaps even, e. g. at

the stage 40 to 45 cm., an increase. At the stage from 25 to 30 cm , 3.5 to 4 years, the weight of the plaice remains unchanged, though their number at 30 cm. only amounts to 58 % of that at 25 cm. And similarly at the stage from 40 to 45 cm. Thus, *the plaice remaining grow so much, that they completely counterbalance the loss in number by the increase in weight.* There is, therefore, no loss in fish-flesh for the fishery at these sizes and ages, there is rather a gain, in so far, that the same quantity by weight of fewer, larger plaice has a greater market-value than the smaller, more numerous plaice. In the weight curves of the representative series 1906/07 and 1907/08 (figs. 25 and 26) this fact is shown by the curve keeping to the same level for some distance at the two places mentioned. In the interval between, on the other hand (from 30 to 40 cm.), the curve drops very steeply and rapidly. Thus, at this stage, that is, in the fifth and sixth year, the plaice do not grow quickly enough for the increase in weight to counterbalance the loss in numbers due to the fishery and other natural causes. When the plaice have reached about 50 cm. and about 9 years on an average, a new period of great percentage decrease in number and weight sets in and this is maintained to the highest attainable age, when, finally, both the number and weight decrease amounts to 100 %.

The following, final summary of the decreases in number and weight in the series of the English plaice landings also gives us information with regard to the biological periods, in which the larger and smaller decreases occur. In this case the length intervals are taken from 10 to 10 cm. The weight decrease from 20 to 30 cm., as also the number decrease, has been estimated by means of the analysis of catch-samples.

Year	Length	Percentage decrease number	Percentage decrease weight	Biological period
4	20—30	77 %	25 %	Males more numerous than females. Almost all ♂ but very few ♀ mature
5— 6	30 –40	89 %	74 %	Great decrease of ♂. Predominance of ♀, now all mature.
7— 9	40—50	56 %	17 %	Gradual, almost complete disappearance of ♂. Greatest development of mature ♀.
10—15	50—60	88 %	78 %	Old age also begins for the ♀.
16—end	60—70	100 %	100 %	Disappearance of last ♂. Greatest age of the ♀.

It thus seems, as if the great decrease of the plaice in number and weight between 30 and 40 cm. in length is connected with the fact, that the males decrease very greatly in number at this stage, both absolutely and relatively by comparison with the females, which are now for their part just at the stage of first maturity. We shall return to these conditions in a later chapter, in which the proportion of the sexes of the plaice according to number and age will be discussed.

One more characteristic in our mixed series of measurements must be mentioned; it is seen not only in the yearly series, but also in almost all the monthly and area series and is connected with the sudden setting in of a great change in the plaice in numbers and weight after 30 cm. Examination of our series shows very clearly, as a rule, that *the number of plaice generally decreases suddenly and very greatly, both absolutely and relatively, from 32 to 33 cm.* This sudden *break or fall* is so great, that the numbers at 33 cm. are not rarely only one half of the amount at 32 cm. This is also seen very clearly in the weight series and is, as a rule, relatively greater than any other decrease in number and weight in the whole series. In the graphic method of representing the measurement series this sudden fall shows itself as a bending of the curve outwards at 32 cm. The great reduction of the plaice in numbers and weight, which suddenly sets in at the stage from 30 to 40 cm., seems, therefore, to begin in reality not from 30 cm. but from 32 cm. The question is now, whether this peculiarity, which recurs with remarkable regularity, arises from the natural, numerical proportions of the plaice or is only a chance appearance, produced perhaps by an insufficient selection of the market-samples measured. In a complex curve derived from several, biologically different series (see p. 47) a *bending of the curve outwards* signifies a more or less concealed, secondary mode at the point of curvature (here at 32 cm.) On close examination, however, I am unable to discover any sign, that perhaps the maximum of a market-class (medium), of which relatively too many have been measured, lies here at 32 cm. or the maximum of a certain, definite year-group or the like. We rather find the remarkable fact, that this sudden fall between 32 and 33 cm. very often occurs also in the English measurements of medium and others, i. e. unsorted plaice, in the case of the Boston measurements very clearly in the so-called big-small. It is also very striking and remarkable, that the same decline usually appears at the same place in the Danish market-measurements of JOHANSEN (108), which were made without any regard for a division into market-classes.

We have finally the question, whether and in how far the composition of the English plaice landings discussed above can also be considered, from a certain length onwards (25 cm.), *representative of the composition of the plaice stock in the North Sea*; in other words, whether our yearly series 1906/07 and 1907/08 or their average, which have proved to be *good market-samples*, are also *good stock-samples* on the descending side (from 25 cm. onwards). And here we are at once obliged to say, that these *yearly series* are probably *not sufficiently representative as stock-samples*. We lack, above all, quite a number of plaice about 25 to 30 cm. long, which hibernate and are thus not taken by the trawl; through the absence of these in the catches and market-landings in the winter months the number of larger plaice must be too great by comparison with the small; probably, also, we lack a number of the smaller plaice, which are not taken in summer, particularly in August, for the reason that, at this time, the plaice fishery

moves somewhat more towards the northern, more lucrative grounds of the North Sea (see p. 129). It is also conceivable, indeed, that the decrease in number of plaice in the landings at the sizes from 30 to 40 cm. is not natural, that is, does not occur in the actual stock, but perhaps artificial, arising from the conditions of the fishery, relative fewer plaice of these sizes being caught than of the other sizes. Consequently, it is necessary to emphasize once more, that the compositition discussed above and the conclusions as to decrease in our plaice series refer directly to the landings and not to the actual stock of plaice.

In a later chapter I shall return to this subject and show, that certain, monthly series of measurements embracing the whole North Sea have probably a higher representative value as stock-samples than these yearly series.

APPENDIX

TABLES

Explanation.

The Tables given in this Appendix to the General Report contain the summaries of plaice measurements — both from the market and research-steamers — which are of special importance for the purpose of examining into and supplementing the conclusions of the Report. These Tables are not reproductions of original Tables from the Reports of the different countries; with few exceptions they are independent summaries and re-arrangements from the extensive, original material, which has been collected within recent years in the different countries and which has partly been published already and is partly still in manuscript. These new summaries were necessary, to bring the new material into a uniform, explanatory system adapted to the purposes of the General Report and thus to make it directly useful. In all cases the sources of the Tables have been indicated.

Most Tables only contain the measurements of the length of the plaice, some few also the weights.

The *length* of the plaice is indicated in whole centimetres, according to the international arrangement. According to the latter the length (l) of a plaice is measured from the mouth, when closed, to the end of the longest caudal ray and parts of a centimetre are disregarded. Thus, the plaice recorded as 25 cm. measure in reality 25.00 to 25.99... cm., and the average of a large number is consequently 25.5 cm. — the central value of the interval. The last however will never occur quite exactly — apart from chance variations due to the fluctuating number of specimens. Since in every large series of measurements of plaice the numbers at the same length increase stage by stage from the lowest to the interval of the highest (maximum) and then decrease step by step from the maximum to the greatest length, the average length of a large number of plaice lying within the same interval will rather be somewhat larger below the maximum, somewhat smaller above the maximum, than the middle of the interval. These differences are so small, however, that they are of no consequence for our conclusions and need not prevent us, in all calculations from the measurements, from taking the middle of the interval between two whole centimetres as the probable average value of the length. According to this 25 cm. in the Tables means 25.5 cm.; in calculating the arithmetic average (A) of the length from the measurements of all plaice, 0.5 cm. has to be added to the value found from the whole centimetres.

The *weights* given in the Tables have not been determined empirically but *calculated theoretically* from the formula 100 w (gm.) = $l^3 \cdot k$, where k = 1. That is, the average weight of a number of plaice of the same size, e. g. 25 cm., is equal to 1 per cent of the third power of their average length (25.5 cm), in this case equal to 166 gm. The total weight of all plaice of 25 cm. in length in Table XVII, namely 461,665 specimens, will thus be 461,665 × 166 gm. = 76,636,390 gm. or 76,636.4 kg. For comparison with the data calculated in this way and given in the Tables, and for further determinations of the weight in other series, the theoretical weight of plaice at each centimetre (middle of interval) is shown in gms. in the following Table for all sizes from 10 to 78 cm.

Length cm.	Weight gm.	Length cm.	Weight gm.	Length cm.	Weight gm.
10.5	12	33.5	376	56.5	1804
11.5	15	34.5	411	57.5	1901
12.5	20	35.5	447	58.5	2002
13.5	25	36.5	486	59.5	2106
14.5	30	37.5	527	60.5	2214
15.5	37	38.5	571	61.5	2326
16.5	45	39.5	616	62.5	2441
17.5	54	40.5	664	63.5	2560
18.5	63	41.5	715	64.5	2683
19.5	74	42.5	768	65.5	2810
20.5	86	43.5	823	66.5	2941
21.5	99	44.5	881	67.4	3075
22.5	114	45.5	942	68.5	3214
23.5	130	46.5	1005	69.5	3357
24.5	147	47.5	1072	70.5	3504
25.5	166	48.5	1141	71.5	3655
26.5	186	49.5	1213	72.5	3811
27.5	208	50.5	1288	73.5	3971
28.5	231	51.5	1366	74.5	4135
29.5	257	52.5	1447	75.5	4304
30.5	284	53.5	1531	76.5	4477
31.5	313	54.5	1619	77.5	4655
32.5	343	55.5	1710	78.5	4837

The number and weight of plaice at each length are noted in the Tables either in *absolute*, i. e. the actual numbers, or in *relative* numbers (usually per 1,000,000) or in both.

Most of the series (for one year, month or catch) in the Tables are *ordinary series of single values.* Sometimes, also, the *summation series* calculated from the ordinary series are given; in these each item is a summation, namely, the sum of the corresponding and all preceding items of the original, ordinary series.

For most series a number of so-called *principal values* have been calculated (cf. p. 48 of the text), chiefly the lower and upper *deciles* (*D*) and *quartiles* (*Qu*), upper

vigintile and the *median* or *central value* of the numbers (M, C); these indicate in cms. and parts of a cm. those lengths under or over which 10 or 90, 25 or 75, 95 or 5 and 50 per cent of the total number (total weight) of all plaice lie.

The median C has been calculated by interpolation from the formula

$$C = g + \frac{(0.5\,S - V)}{J_C},$$

where g is the beginning of the interval in which the median lies, S the sum of all plaice in the whole series, V the sum of all plaice which lie *before* the interval containing the median and J_C the number of plaice which fall within the latter interval. For example, if g is equal to 25.0, the second part on the right side of the above equation always gives a fraction of 1, e. g. 0.37, and the median would thus be 25.37. In calculating the median for a weight series, the symbols S, V and J no longer indicate number of specimens but weights. The other principal values are calculated in the same way; thus, for the deciles 0.10 and 0.90 S replace 0.5 in the above equation, for the quartiles 0.25 and 0.75 S, for the upper vigintile 0.95 S and for J the number of specimens in the other intervals dealt with.

In the following Tables, these principal values themselves are not given, but the intervals in which they lie are indicated by the heavy type; the interval of the median is further emphasized by an *. The principal values, calculated to 2 places of decimals, will be found at the places concerned in the text of this Report.

Tab. I. English Mark

Area A_3. Analysis of all plaice-samples measured in the three years, arrang (relative a

The numbers printed in heavy type in each column indicate the intervals of length in w

Month	January	February	March [1]	April	May	June	July
Absolute nos.	.	3 113	4 229	30 269	57 553	76 042	21 065
Relative »	.	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000
cm							
16	.	.	.	198	.	.	.
17	.	.	.	198	.	.	.
18	.	.	37 315	2 874	.	789	190
19	.	25 056	59 141	12 918	10 599	4 116	2 326
20	.	75 168	**91 997**	54 809	40 831	25 460	10 492
21	.	**87 696**	**83 783**	**88 110**	**74 678**	61 611	30 528
22	.	**97 333**	76 743	**112 326**	100 011	**107 519**	**62 290**
23	.	98 618	74 161	111 302	**115 110**	**130 822**	87 310
24	.	*) **123 674**	61 253	103 208	129 548	138 134	**125 339**
25	.	122 710	*) **58 437**	*) **88 639**	*) **102 356**	*) **108 637**	142 241
26	.	**123 352**	57 264	82 659	97 926	97 591	*) **126 716**
27	.	73 240	43 886	66 173	77 406	74 445	96 188
28	.	61 355	52 100	**67 495**	**68 075**	**68 830**	**82 515**
29	.	**34 372**	**67 590**	54 412	54 870	55 982	70 361
30	.	23 129	61 488	46 781	**44 306**	**47 119**	60 675
31	.	**16 062**	60 314	**38 323**	31 953	**31 377**	**43 489**
32	.	12 849	**47 172**	**27 156**	**21 285**	19 489	**26 207**
33	.	11 886	**31 213**	17 378	13 605	11 888	16 949
34	.	5 140	12 908	11 596	8 201	7 272	9 828
35	.	1 606	7 979	7 334	4 830	4 761	4 463
36	.	3 855	5 632	3 733	2 520	2 485	1 614
37	.	1 927	1 173	1 751	1 338	947	142
38	.	964	939	429	382	460	142
39	.	.	.	198	70	210	.
40	.	.	.	.	70	40	.
41	.	.	.	.	.	.	.
42	.	.	.	.	.	.	.
43	.	.	.	.	.	13	.
44	.	.	.	.	.	.	.
45	.	.	.	.	17	.	.

[1] N.B. In addition to the 4 229 plaice for March, the English measurements also contain 32 specimens of large for M

asurements 1905—08.

ording to months (relative numbers) and the sum of all months (Year) olute numbers).

ne *D*, *Q*, *M(C)*, *Q*, *D*, *V*-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
4 359	6 469	1 194	10 906	10 422	225 619	.	
000 000	1 000 000	1 000 000	1 000 000	1 000 000	.	1 000 000	
							cm
.	.	.	.	.	6	27	16
.	.	.	2 384	.	32	142	17
1 835	.	.	14 304	.	474	2 101	18
5 965	3 246	15 913	29 158	5 661	2 136	9 467	19
30 741	14 840	72 027	**55 841**	72 635	8 474	37 559	20
69 970	41 737	**173 367**	68 128	**86 164**	15 346	**68 017**	21
107 364	**72 345**	206 867	79 497	**97 582**	22 341	99 021	22
125 946	107 744	**154 941**	**76 747**	84 341	25 551	**113 248**	23
131 911	**140 825**	*) **201 842**	86 650	94 512	28 027	124 223	24
110 346	*) **132 787**	**98 827**	83 715	*) **93 744**	23 810	*) **105 532**	25
95 893	120 111	**45 226**	*) **86 191**	110 056	22 192	98 361	26
67 447	88 267	15 913	76 838	90 482	17 225	76 346	27
39 459	**81 774**	9 213	76 472	**79 927**	15 725	**69 697**	28
36 247	71 572	2 513	**65 285**	62 848	12 930	57 309	29
35 788	**51 476**	3 350	62 168	**48 743**	10 840	**48 046**	30
39 688	**38 182**	.	**44 838**	**27 922**	7 808	34 607	31
36 706	17 622	.	35 668	19 670	5 190	**23 003**	32
26 612	7 729	.	**26 591**	14 393	3 346	14 830	33
18 123	4 483	.	15 863	6 716	2 005	8 887	34
10 323	2 319	.	6 969	3 646	1 169	5 181	35
5 047	2 010	.	3 851	768	602	2 668	36
2 982	155	.	1 467	.	246	1 090	37
1 147	464	.	550	192	96	426	38
459	309	.	367	.	34	151	39
.	.	.	275	.	10	44	40
.	.	.	183	.	2	9	41
.	.	.	.	.	.	.	42
.	.	.	.	.	1	4	43
.	.	.	.	.	.	.	44
.	.	.	.	.	1	4	45
.	.	.	.	.			

from 49 to 61 cm in length, These plaice have been omitted from this Table.

Tab. II. English Marke

Area B_4. Analysis of all plaice-samples measured in the three years, arrange (relative an

The numbers printed in heavy type in each column indicate the intervals of length in whi

Month	January	February	March	April	May	June	July
Absolute nos.	23 303	20 878	14 747	59 275	89 508	61 920	36 041
Relative »	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000
cm							
16	.	.	.	.	.	.	.
17	.	.	4 543	.	1 307	.	.
18	.	6 179	7 391	.	4 033	65	.
19	.	14 418	13 969	3 509	11 518	1 550	.
20	12 186	29 602	44 958	30 535	41 996	16 166	20 615
21	23 172	44 116	**87 340**	65 236	**81 835**	43 879	47 751
22	41 322	**45 936**	**119 143**	**90 541**	**119 753**	**82 494**	**81 601**
23	**50 848**	50 343	124 975	**104 847**	124 400	**113 631**	100 746
24	62 477	55 660	*) **119 007**	113 097	*) **123 864**	134 578	**116 644**
25	**72 218**	**62 940**	92 154	*) **104 796**	98 872	109 707	113 453
26	87 150	68 545	79 542	104 712	82 326	*) **98 902**	*) **114 619**
27	86 936	65 335	**61 640**	84 637	**66 116**	75 937	83 682
28	*) **81 315**	*) **70 413**	48 620	**72 457**	63 390	74 774	**74 886**
29	76 594	64 617	40 957	60 091	50 531	**62 129**	59 349
30	67 369	62 030	30 515	47 590	**44 532**	55 087	50 942
31	48 317	49 672	26 514	**37 502**	29 740	**40 892**	**42 923**
32	40 250	43 301	**21 564**	26 416	**23 953**	31 315	35 487
33	**33 170**	**34 152**	19 868	**18 068**	13 328	**19 493**	**22 114**
34	24 588	29 602	**12 613**	13 412	7 709	12 758	14 789
35	18 280	20 405	10 443	8 520	4 703	8 592	8 851
36	14 761	18 297	6 984	5 500	2 324	5 345	5 410
37	13 345	14 945	3 051	3 324	1 262	3 391	2 691
38	15 019	14 801	1 085	**1 704**	759	2 261	1 471
39	13 002	13 268	68	793	480	1 292	999
40	12 358	9 244	136	354	246	1 179	444
41	**9 097**	6 179	.	34	123	517	305
42	8 282	**6 274**	203	.	156	630	83
43	10 084	7 472	814	17	156	468	55
44	8 840	6 370	1 221	85	100	291	28
45	7 509	6 993	1 899	101	56	291	.
46	7 338	6 945	1 899	118	112	355	.
47	**5 321**	5 700	2 441	186	56	371	55
48	5 836	6 754	2 509	169	45	210	.
49	4 034	6 083	1 899	169	67	307	.
50	4 763	**7 376**	1 899	219	22	355	.
51	4 506	6 706	1 695	219	33	226	.
52	3 905	6 131	1 424	85	11	145	.
53	3 776	5 508	1 153	68	45	129	.
54	3 218	4 886	746	101	.	81	.
55	3 175	4 550	610	152	22	81	.
56	2 532	3 113	949	68	.	32	.
57	1 845	2 826	407	135	.	48	.
58	2 146	3 113	407	152	22	32	.
59	2 146	2 203	136	85	.	.	.
60	1 588	1 293	203	68	.	16	.
61	1 416	1 245	271	17	.	.	.
62	1 330	766	.	68	.	.	.
63	858	1 293	68	.	.	.	.
64	644	670	.	.	.	.	.
65	258	431	.	.	.	.	.
66	429	383	.	.	.	.	.
67	129	287	.	.	.	.	.
68	129	431	68	.	.	.	.
69	172	96	.	17	.	.	.
70	.	48	.	.	.	.	.
71	.	96	.	.	.	.	.

asurements 1905—08.

ording to months (relative numbers) and the sum of all months (Year) olute numbers).

e *D*, *Q*, *M*(*C*), *Q*, *D*, *V*-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
31 238	33 504	87 647	76 478	49 693	584 232		
000 000	1 000 000	1 000 000	1 000 000	1 000 000		1 000 000	
							cm
.	.	262	.	.	23	39	16
.	.	308	.	.	211	361	17
.	.	4 073	5 361	2 093	1 474	2 523	18
64	2 627	6 903	14 671	2 938	3 805	6 513	19
15 814	35 070	26 527	36 638	14 992	16 419	28 104	20
41 712	56 172	54 297	**47 922**	35 900	31 772	54 383	21
79 070	**92 048**	**94 493**	70 334	**56 185**	49 821	**85 276**	22
92 195	**103 271**	**129 200**	**85 998**	74 719	60 050	**102 784**	23
06 504	111 120	160 861	113 666	**98 668**	69 446	118 867	24
01 222	96 824	*) **149 121**	115 510	110 478	64 100	*) **109 716**	25
10 281	*) **92 317**	**133 273**	*) **118 321**	*) **129 736**	62 181	106 432	26
91 938	75 035	85 901	98 577	114 342	49 088	84 021	27
78 846	74 229	**60 116**	**85 894**	**101 422**	43 208	**73 957**	28
74 268	**65 962**	35 483	67 483	76 590	34 416	58 908	29
56 693	66 230	**24 131**	**48 720**	59 525	28 158	48 197	30
43 920	**47 099**	12 699	31 499	**38 738**	19 915	**34 087**	31
35 469	30 593	7 667	**22 242**	**28 374**	15 003	25 680	32
24 777	**19 669**	4 564	13 494	17 125	9 763	**16 711**	33
15 462	13 252	3 172	9 231	11 913	6 688	11 448	34
10 116	8 118	2 248	5 936	6 943	4 367	7 475	35
7 523	3 940	1 495	3 347	3 763	2 830	4 844	36
4 290	2 358	970	1 556	2 133	1 808	3 095	37
2 209	1 403	764	955	1 670	1 376	2 355	38
1 024	985	650	327	1 067	987	1 689	39
768	776	479	340	885	777	1 330	40
992	328	114	131	543	486	832	41
672	388	91	183	986	487	834	42
384	90	126	105	724	518	887	43
736	90	.	157	765	466	798	44
704	.	11	118	785	449	769	45
416	.	.	209	906	457	782	46
576	.	.	222	624	386	661	47
192	.	.	183	684	395	676	48
256	.	.	78	543	325	556	49
320	.	.	157	523	378	647	50
192	.	.	78	523	338	579	51
192	.	.	78	402	287	491	52
.	.	.	65	241	253	433	53
96	.	.	52	503	231	395	54
32	.	.	39	181	207	354	55
.	.	.	26	342	163	279	56
64	.	.	13	121	128	219	57
.	.	.	13	121	141	241	58
.	.	.	.	60	106	181	59
.	.	.	26	60	77	132	60
.	.	.	13	40	67	115	61
.	.	.	13	60	55	94	62
.	.	.	.	20	49	84	63
.	.	.	13	20	31	53	64
.	.	.	.	.	15	26	65
.	.	.	.	.	18	31	66
.	.	.	.	20	10	17	67
.	.	.	.	.	13	22	68
.	.	.	.	.	7	12	69
.	.	.	.	.	1	2	70
.	.	.	.	.	2	3	71

Tab. III. English Mark

Area B_3. Analysis of all plaice-samples measured in the three years, arrang (relative a

The numbers printed in heavy type in each column indicate the intervals of length in wh

Month	January	February	March	April	May	June	July
Absolute nos.	112 287	107 327	248 342	276 948	236 768	258 543	165 416
Relative »	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000
cm							
15	.	.	.	79	.	.	.
16	.	.	.	383	30	.	.
17	.	1 146	1 655	1 145	1 618	2 255	1 324
18	1 710	12 652	9 459	7 453	6 665	8 242	5 676
19	7 837	29 386	29 665	24 969	20 713	21 265	17 761
20	21 232	**61 604**	56 132	46 984	44 407	48 065	38 981
21	41 342	85 260	**80 441**	**78 824**	**74 855**	**75 418**	**59 626**
22	**62 814**	**96 079**	**107 098**	103 063	95 614	**98 265**	77 979
23	83 788	89 639	120 849	**115 401**	**103 271**	101 402	**87 453**
24	**89 309**	84 580	*) **117 604**	*) **112 874**	110 227	105 456	92 174
25	88 926	*) **75 397**	104 467	107 082	*) **103 546**	*) **100 741**	91 696
26	74 597	71 079	81 311	80 820	85 266	81 823	*) **78 245**
27	*) **67 677**	49 921	**62 905**	66 348	73 773	72 204	70 894
28	63 785	43 278	49 476	**56 718**	**65 322**	**64 407**	66 995
29	58 405	38 312	38 338	44 203	52 026	55 372	58 108
30	56 740	**36 327**	31 928	36 509	44 267	46 448	**54 003**
31	**47 638**	30 933	**24 374**	**27 175**	**33 100**	**33 023**	44 512
32	42 847	27 317	19 155	22 210	25 633	28 235	39 168
33	31 856	21 643	12 704	14 302	**15 610**	**16 160**	**26 001**
34	27 021	19 864	**10 184**	**12 645**	13 291	13 093	21 026
35	21 695	16 044	7 421	10 052	8 776	8 853	15 113
36	**16 413**	**11 982**	5 621	6 398	5 317	5 492	**11 426**
37	13 661	10 743	4 317	5 272	3 919	3 686	8 796
38	11 221	9 923	3 511	4 770	3 231	2 336	6 922
39	8 870	8 861	2 637	3 719	2 188	1 578	5 175
40	8 416	7 985	2 190	2 506	1 736	1 381	4 147
41	**7 107**	6 624	1 893	1 639	1 347	971	3 258
42	6 608	**6 326**	1 611	1 275	946	874	2 775
43	5 735	5 916	1 623	1 025	832	728	2 370
44	4 871	5 721	1 574	755	591	557	1 910
45	4 649	4 985	1 397	538	469	538	1 608
46	3 793	4 277	1 425	441	325	317	1 276
47	3 081	3 857	1 305	339	291	251	973
48	2 983	3 923	1 168	361	228	190	858
49	2 777	3 187	866	300	177	139	671
50	2 591	3 075	701	285	139	66	429
51	1 745	2 227	548	213	93	39	206
52	1 149	1 761	536	170	63	35	103
53	1 166	1 556	395	112	25	39	121
54	703	1 249	266	152	25	8	79
55	614	1 006	270	112	21	23	54
56	463	997	165	134	13	8	66
57	454	596	177	47	8	.	18
58	507	466	133	61	.	8	18
59	231	485	141	40	4	4	.
60	285	419	64	43	.	.	.
61	205	317	36	25	.	.	6
62	124	317	72	7	4	.	.
63	89	224	24	11	.	.	.
64	35	177	56	11	4	.	.
65	124	140	24	.	.	.	.
66	27	65	28	4	.	.	.
67	27	112	36	.	.	.	.
68	27	19	12	.	.	.	.
69	35	.	.	.	.	.	.
70	.	.	8	.	.	.	.
71	9	.	.	.	.	.	.

asurements 1905—08.

ording to months (relative numbers) and the sum of all months (Year) olute numbers).

é D, Q, M(C), Q, D, V-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
140 042	173 058	184 243	169 691	139 904	2 212 548		
000 000	1 000 000	1 000 000	1 000 000	1 000 000		1 000 000	
							cm
.	.	.	.	.	22		15
.	.	.	.	.	113	51	16
.	.	75	.	.	2 051	927	17
2 306	873	1 683	4 915	3 109	12 664	5 724	18
10 604	7 518	12 228	14 915	11 401	40 821	18 450	19
37 132	25 853	31 290	28 227	26 318	89 248	40 337	20
62 460	55 334	**56 382**	51 416	47 983	146 834	**66 364**	21
88 338	**86 318**	87 102	**78 901**	**76 088**	200 841	90 774	22
100 805	**108 154**	**112 465**	**113 045**	**102 070**	233 353	**105 468**	23
107 218	118 278	126 192	126 770	117 323	244 842	110 661	24
108 032	*) **108 680**	*) **118 962**	*) **121 119**	*) **118 017**	232 326	*) **105 004**	25
91 965	90 403	93 355	93 404	85 880	186 456	84 272	26
81 418	77 563	81 419	79 774	73 315	158 436	71 608	27
69 143	69 196	**67 096**	**62 631**	59 827	136 020	**61 477**	28
54 991	**59 084**	54 982	48 688	**47 418**	111 631	50 454	29
48 621	49 648	44 647	41 799	41 843	96 307	43 528	30
36 653	36 467	**32 528**	31 433	35 110	73 669	33 296	31
28 384	**28 389**	22 915	**24 267**	28 562	59 723	**26 993**	32
18 566	18 271	**15 621**	17 408	21 579	39 804	17 990	33
13 703	**14 694**	10 383	12 305	**16 511**	31 780	14 364	34
9 697	10 418	7 935	**8 610**	13 481	23 622	**10 676**	35
6 834	6 790	5 048	6 311	9 692	16 355	7 392	36
4 970	5 721	3 398	4 921	7 620	12 768	5 771	37
3 449	5 276	2 627	3 966	6 004	10 425	4 712	38
2 556	3 219	2 117	3 294	**5 311**	8 021	3 625	39
1 992	2 583	1 699	2 711	4 689	6 649	3 005	40
1 450	2 092	1 384	2 469	4 496	5 410	2 445	41
1 492	2 057	1 189	2 204	4 353	4 850	2 192	42
1 407	1 676	1 178	1 903	4 367	4 381	1 980	43
1 214	1 289	939	1 721	4 489	3 847	1 739	44
1 128	1 081	863	1 609	3 988	3 404	1 538	45
928	826	537	1 391	3 152	2 780	1 256	46
721	682	543	1 344	3 216	2 470	1 116	47
486	474	369	1 344	3 038	2 262	1 022	48
343	335	233	1 037	2 445	1 808	817	49
271	208	239	943	2 323	1 598	722	50
214	139	98	654	1 201	1 047	473	51
93	98	65	536	1 058	820	371	52
129	52	38	530	872	709	320	53
78	81	65	471	622	546	247	54
107	35	22	230	386	413	187	55
36	23	33	253	200	339	153	56
14	17	22	112	164	228	103	57
36	23	16	124	107	210	95	58
7	17	.	65	143	161	73	59
7	40	5	65	86	137	62	60
.	6	.	47	29	87	39	61
.	12	11	35	36	84	38	62
.	6	.	18	14	49	22	63
.	.	.	18	36	48	22	64
.	.	.	18	7	40	18	65
.	.	.	6	.	19	9	66
.	.	.	.	7	25	11	67
.	.	.	6	.	9	4	68
.	.	.	.	.	4	2	69
.	.	.	.	7	3	1	70
.	.	.	.	7	1	0,5	71

Tab. VI. English Mark

Area C_3. Analysis of all plaice-samples measured in the three years arrang (relative a

The numbers printed in heavy type in each column indicate the intervals of length in w

Month	January	February	March	April	May	June	July
Absolute nos.	83 621	97 232	48 416	13 830	24 916	16 238	29 412
Relative »	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000
cm							
17	478	.	248	.	.	.	306
18	5 309	2 036	2 313	7 014	6 301	616	4 828
19	15 271	8 814	9 708	18 800	21 873	5 358	15 368
20	27 539	22 081	24 455	51 265	56 109	21 862	36 482
21	40 442	41 313	44 923	**98 698**	**85 447**	49 144	**53 788**
22	**70 241**	**60 073**	**74 232**	**131 526**	**105 274**	**83 939**	66 095
23	88 956	78 472	94 762	130 586	117 234	88 989	69 189
24	**91 682**	85 929	**103 953**	*) **122 777**	*) **117 876**	**96 872**	**80 613**
25	88 418	**85 301**	98 583	106 001	115 589	92 068	88 977
26	68 101	70 964	*) **74 046**	78 742	85 688	*) **69 713**	81 327
27	*) **62 457**	*) **61 616**	62 190	**51 916**	**66 825**	62 015	*) **79 287**
28	51 790	51 670	47 773	39 841	53 821	63 739	74 153
29	45 118	48 719	46 286	36 153	44 550	57 951	66 367
30	46 433	48 945	44 407	30 296	29 018	48 151	**58 378**
31	46 577	46 168	**41 433**	**23 644**	**26 248**	**50 868**	53 550
32	**43 013**	**48 688**	40 565	17 571	20 910	40 953	42 432
33	39 234	42 846	33 439	10 991	**11 238**	30 115	30 056
34	33 590	39 102	29 412	**11 569**	8 549	25 619	**25 432**
35	28 077	34 114	26 458	6 941	5 579	**20 200**	17 306
36	**21 142**	26 051	**22 224**	5 640	3 451	17 428	**11 084**
37	16 933	**20 343**	17 122	4 917	3 733	14 472	9 316
38	12 460	15 890	12 744	3 615	2 850	10 592	7 480
39	**10 069**	11 869	**10 637**	3 037	2 087	**10 161**	5 950
40	8 598	**10 131**	8 179	1 880	1 806	7 390	3 774
41	6 972	8 783	6 857	940	1 164	5 789	3 604
42	5 668	6 613	4 647	1 374	1 605	4 865	3 468
43	4 305	5 101	4 523	723	1 244	3 510	3 230
44	4 138	3 826	2 602	795	1 003	3 387	2 550
45	2 798	2 684	2 065	795	722	3 018	1 938
46	2 463	2 139	1 838	579	642	2 833	1 666
47	2 368	2 098	1 446	579	682	2 155	918
48	1 746	1 779	1 239	362	401	1 540	510
49	1 782	1 491	971	289	401	1 109	476
50	1 112	1 008	578	72	80	739	102
51	729	597	537	72	.	554	.
52	765	494	372	.	.	554	.
53	646	350	330	.	.	308	.
54	466	339	269	.	.	493	.
55	443	247	269	.	.	431	.
56	335	144	227	.	.	185	.
57	335	237	227	.	.	62	.
58	203	216	207	.	.	62	.
59	144	165	124	.	.	123	.
60	156	123	207	.	.	.	.
61	144	144	103	.	.	.	.
62	84	82	124	.	.	62	.
63	36	21	21	.	.	.	.
64	60	62	41	.	.	.	.
65	24	21	41	.	.	.	.
66	60	31	21	.	.	.	.
67	12	41	21	.	.	.	.
68	12	10	.	.	.	.	.
69	12	21	.	.	.	.	.

easurements 1905—08.

cording to months (relative numbers) and the sum of all months (Year)
solute numbers).

the D, Q, $M(C)$, Q, D. V-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
55 049	51 114	20 567	21 880	52 718	515 003		
1 000 000	1 000 000	1 000 000	1 000 000	1 000 000		1 000 000	
							cm
272	.	.	.	.	76	148	17
1 199	1 017	97	.	5 084	1 548	3 006	18
5 177	5 282	3 258	457	25 854	5 923	11 501	19
16 930	14 458	13 079	7 724	34 959	13 121	25 478	20
28 120	35 470	29 173	21 161	**39 379**	21 948	42 617	21
41 436	**54 975**	53 824	50 823	65 177	33 804	**65 639**	22
51 100	74 598	**85 088**	**82 907**	**87 636**	42 674	82 862	23
62 344	**87 236**	**99 869**	**108 958**	92 530	46 841	**90 953**	24
76 114	91 443	115 962	114 168	89 628	47 391	92 021	25
88 267	80 115	91 263	98 812	*) **71 512**	39 691	77 070	26
86 268	*) **83 324**	*) **92 235**	*) **92 368**	65 177	36 309	*) **70 503**	27
*) **84 761**	82 365	88 540	74 269	55 901	32 045	62 223	28
82 417	79 606	69 820	64 031	47 934	29 224	56 745	29
80 147	**71 468**	**56 061**	**56 810**	46 398	27 340	53 087	30
67 558	55 288	49 934	46 892	**51 405**	25 080	**48 699**	31
59 837	44 763	42 690	38 163	45 544	22 668	44 015	32
43 307	31 126	**32 382**	29 433	35 548	18 030	35 010	33
34 097	**25 414**	21 734	**24 177**	30 502	15 332	29 771	34
24 524	19 349	**14 100**	18 464	**23 426**	12 286	**23 852**	35
15 768	**13 969**	9 335	15 631	15 744	9 096	17 662	36
11 517	9 782	6 515	**11 654**	13 145	7 109	13 804	37
9 918	8 041	4 765	7 495	10 053	5 466	**10 614**	38
6 412	5 830	4 230	8 227	8 138	4 292	8 334	39
4 414	4 441	3 209	5 302	**6 298**	3 386	6 575	40
3 233	3 267	3 063	4 753	5 197	2 797	5 431	41
2 888	2 935	1 993	3 062	5 368	2 282	4 431	42
2 053	2 798	1 702	3 336	4 097	1 848	3 588	43
2 289	2 348	1 604	2 331	3 339	1 516	2 944	44
1 980	1 819	1 264	2 057	3 244	1 204	2 338	45
1 689	2 602	1 313	1 417	1 916	1 007	1 955	46
1 290	1 839	778	1 097	1 916	865	1 680	47
945	1 565	534	1 188	1 328	673	1 307	48
545	704	292	594	1 385	545	1 058	49
345	293	194	457	1 005	338	656	50
145	39	.	137	645	202	392	51
109	78	.	365	493	183	355	52
145	78	.	411	455	154	299	53
73	20	49	228	531	132	256	54
73	39	.	46	284	103	200	55
91	78	49	183	247	83	161	56
18	59	.	46	341	86	167	57
36	20	.	46	209	64	124	58
73	20	.	91	247	56	109	59
.	20	.	.	171	45	87	60
.	20	.	46	190	43	84	61
18	.	.	.	114	29	56	62
18	.	.	183	114	17	33	63
18	.	.	.	76	18	35	64
.	.	.	.	38	8	16	65
.	.	.	.	76	13	25	66
18	.	.	.	.	7	14	67
.	.	.	.	.	2	4	68
.	.	.	.	.	3	6	69

Tab. V. English Mar

Area B_2. Analysis of all plaice-samples measured in the three years arran (relative

The numbers printed in heavy type in each column indicate the intervals of length in

Month	January	February	March	April	May	June	July
Absolute nos.	14 467	18 062	43 792	51 281	31 908	34 209	59 4
Relative »	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 0
cm							
17	.	.	.	.	.	.	72
18	.	.	365	117	533	497	2 82
19	.	111	5 480	6 707	2 977	2 339	4 18
20	1 521	2 658	20 004	20 883	13 351	11 079	15 41
21	6 083	17 883	34 162	44 632	36 104	29 992	25 60
22	17 557	31 890	**53 731**	**72 983**	**66 754**	52 676	45 55
23	35 667	47 005	64 395	84 974	78 444	**64 603**	**56 43**
24	**53 086**	**69 871**	**82 047**	**94 295**	**90 385**	79 657	66 76
25	62 279	80 999	91 820	90 493	93 205	**85 474**	**72 72**
26	**75 896**	**96 612**	98 214	81 016	106 964	81 557	80 36
27	77 209	90 134	*) **90 108**	*) **70 097**	*) **101 792**	77 786	74 38
28	80 389	*) **88 861**	89 811	68 186	89 225	*) **69 426**	*) **74 25**
29	86 403	78 729	74 534	61 596	68 102	69 163	70 68
30	*) **89 444**	76 071	**75 242**	**58 301**	**60 236**	66 503	71 69
31	79 974	59 739	48 319	47 342	45 224	**62 381**	65 91
32	77 001	**53 261**	39 574	41 454	33 064	53 553	**65 47**
33	**61 588**	42 243	29 275	31 529	**23 442**	38 528	48 83
34	55 228	31 780	**22 904**	**28 078**	15 827	35 195	41 65
35	39 814	24 305	15 117	20 941	14 918	**28 677**	**30 89**
36	**26 958**	**17 994**	9 499	15 560	8 995	24 175	20 74
37	17 488	12 623	**6 508**	**12 109**	**6 237**	**16 575**	14 67
38	**11 198**	9 246	4 476	8 852	4 732	10 904	**10 27**
39	7 742	5 869	3 448	6 337	3 228	8 156	7 59
40	4 977	4 927	3 836	5 128	3 477	5 379	5 48
41	3 456	3 433	3 814	4 173	3 197	4 473	4 01
42	3 041	**4 152**	3 243	4 056	3 165	3 596	3 42
43	2 558	3 709	2 900	3 354	3 197	2 368	2 95
44	2 488	5 149	3 174	3 139	3 228	2 689	2 87
45	2 558	4 318	3 197	2 554	3 291	2 485	2 69
46	1 935	4 263	2 740	1 794	3 259	1 462	2 15
47	2 212	4 263	2 763	1 540	3 197	1 520	1 90
48	1 659	2 934	2 169	1 345	1 943	1 783	1 71
49	2 074	2 990	2 261	1 209	2 413	1 432	1 54
50	1 866	2 934	1 918	799	1 379	1 052	97
51	1 382	2 436	1 918	760	1 254	877	62
52	1 452	3 100	1 279	819	972	614	50
53	968	2 325	1 324	643	815	439	40
54	1 037	2 879	1 302	585	439	175	28
55	899	2 713	799	565	219	351	20
56	968	1 716	639	234	313	205	30
57	346	1 218	457	234	125	117	10
58	415	886	388	175	219	58	67
59	484	277	365	136	31	29	34
60	69	664	206	156	94	.	.
61	346	221	114	19	31	.	17
62	69	332	46	58	.	.	17
63	138	55	46	.	.	.	.
64	.	166	69	.	.	.	17
65	.	.	.	.	.	.	17
66	.	55	.	19	.	.	.
67	69	.	.	19	.	.	.

asurements 1905—08.

ording to months (relative numbers) and the sum of all months (Year)
olute numbers).

ne *D*, *Q*, *M*(*C*), *Q*, *D*, *V*-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
43 091	30 885	21 921	21 690	10 600	381 309		
000 000	1 000 000	1 000 000	1 000 000	1 000 000		1 000 000	
							cm
.	.	.	.	.	43	113	17
232	65	.	92	.	238	624	18
719	907	2 281	3 504	.	1 095	2 872	19
8 146	11 883	19 798	11 987	1 226	5 164	13 543	20
24 298	38 077	33 165	29 460	7 358	11 564	30 327	21
46 205	**72 786**	**71 894**	53 342	14 528	20 694	**54 271**	22
65 212	105 196	95 844	**81 420**	33 019	26 889	70 518	23
86 353	**131 617**	**122 029**	**100 184**	**64 528**	33 358	**87 483**	24
91 969	104 872	130 514	108 575	76 981	34 484	90 436	25
97 748	*) **99 109**	*) **113 955**	97 556	**97 547**	35 204	92 324	26
89 556	76 412	81 018	*) **83 540**	88 679	31 367	*) **82 261**	27
86 771	66 213	59 851	67 727	83 679	29 289	76 812	28
77 976	**57 892**	**44 432**	59 751	*) **68 679**	25 985	68 147	29
72 220	54 395	42 972	51 683	61 887	24 926	65 370	30
62 496	36 296	38 046	**47 026**	67 925	20 666	**54 198**	31
52 842	33 479	32 252	42 646	57 453	18 269	47 911	32
37 270	**25 902**	**27 782**	29 368	**59 057**	13 802	36 196	33
28 429	18 553	23 904	26 648	51 509	11 449	**30 026**	34
20 747	12 045	**16 970**	**20 332**	38 585	8 534	22 381	35
14 087	**9 195**	11 724	17 335	**28 868**	6 107	16 016	36
8 795	6 540	6 980	11 757	23 962	4 269	**11 196**	37
6 707	5 958	4 653	**9 636**	17 736	3 086	8 093	38
4 989	4 371	3 832	7 745	**9 623**	2 232	5 854	39
3 319	4 177	2 372	7 238	8 491	1 784	4 679	40
1 787	3 497	2 327	5 210	5 472	1 394	3 656	41
1 810	2 882	2 372	4 426	6 698	1 283	3 365	42
1 624	2 979	1 597	4 334	4 717	1 103	2 893	43
1 323	2 979	1 323	2 997	3 585	1 076	2 822	44
1 717	2 720	1 186	2 720	2 547	1 016	2 665	45
1 067	1 813	593	2 720	2 925	804	2 109	46
905	1 716	639	1 660	2 075	740	1 941	47
603	1 489	730	1 429	2 547	612	1 605	48
650	1 327	547	1 106	1 698	586	1 537	49
371	842	182	1 060	1 415	427	1 120	50
278	615	274	830	943	359	941	51
255	324	365	738	1 038	313	821	52
209	162	274	507	472	248	650	53
93	453	182	645	755	235	616	54
116	97	182	184	660	180	472	55
70	65	91	277	377	137	359	56
.	32	91	184	94	81	212	57
.	32	228	92	377	73	191	58
46	.	91	92	189	47	123	59
.	.	137	138	94	40	105	60
.	.	91	.	.	19	50	61
.	.	46	92	.	16	42	62
.	.	**91**	.	.	7	18	63
.	32	46	.	.	9	21	64
.	.	**46**	.	.	2	5	65
.	.	.	.	.	2	5	66
.	.	.	.	.	2	5	67

Tab. VII. English Mark

Area C_1. Analysis of all plaice-samples measured in the three years, arrang (relative a

The numbers printed in heavy type in each column indicate the intervals of length in wh

Month	January	February	March	April	May	June	July
Absolute nos.	8 391	11 017	4 673	8 737	6 737	3 289	4 659
Relative »	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000
cm							
20	.	4 085	1 070	.	.	.	.
21	238	10 710	6 206	2 289	3 266	2 128	429
22	6 912	20 423	22 897	10 873	7 422	4 865	5 151
23	15 492	31 678	39 375	22 204	16 625	9 425	8 586
24	28 958	**44 931**	**52 429**	38 457	27 312	10 033	16 312
25	**51 256**	50 377	66 767	**52 879**	38 890	9 425	27 044
26	84 372	60 271	**96 726**	68 559	**46 015**	11 554	33 698
27	**91 284**	**64 809**	103 360	**75 999**	52 842	14 898	**43 571**
28	105 823	64 356	104 858	81 950	**62 045**	34 053	50 225
29	107 849	62 177	*) **82 388**	72 107	83 865	**51 383**	**65 894**
30	*) **101 533**	62 086	78 322	*) **79 089**	78 076	72 058	85 426
31	64 119	*) **62 539**	62 915	67 758	72 436	**94 253**	86 499
32	58 398	61 542	**43 227**	60 433	*) **66 350**	97 293	*) **90 577**
33	**57 207**	65 536	31 243	50 704	57 444	89 692	71 045
34	47 315	54 643	23 539	40 632	47 796	*) **62 936**	56 879
35	32 536	**40 301**	16 264	26 783	34 288	49 559	36 059
36	23 002	36 035	12 412	**19 458**	23 156	38 613	24 469
37	15 255	23 690	11 770	16 711	18 109	32 228	16 312
38	7 747	17 064	9 414	12 705	12 320	19 763	13 308
39	**4 767**	12 163	6 848	12 819	**11 578**	15 506	14 166
40	4 539	11 618	6 420	8 813	10 336	12 770	**11 590**
41	3 576	8 441	6 420	8 241	11 132	13 074	14 810
42	3 576	8 895	7 062	8 928	15 140	**17 634**	17 815
43	3 576	6 989	6 420	9 614	15 586	23 107	24 039
44	6 436	7 897	6 420	13 849	17 960	23 411	20 391
45	7 747	**7 988**	**8 346**	14 879	17 363	26 452	25 756
46	8 104	9 712	10 914	13 620	17 218	26 452	19 961
47	5 483	12 435	8 132	**13 162**	18 703	21 587	**21 035**
48	**7 985**	12 798	9 416	11 674	15 437	**17 938**	16 742
49	7 628	10 801	10 486	12 361	**17 812**	17 330	21 464
50	7 628	**9 984**	**9 844**	11 331	15 882	15 506	**12 234**
51	6 555	7 625	4 708	**13 620**	15 586	**18 242**	11 376
52	6 198	5 628	3 852	8 813	**10 093**	13 074	8 586
53	6 436	5 718	4 066	8 699	7 867	8 209	7 512
54	4 291	4 811	4 066	5 952	6 976	6 385	5 366
55	2 622	3 540	4 066	6 295	5 047	5 473	3 649
56	1 430	2 542	3 638	4 922	5 492	3 953	4 293
57	596	3 540	3 210	3 891	4 008	3 953	4 293
58	715	1 271	2 996	3 319	4 750	1 520	859
59	358	2 178	642	2 518	2 227	2 432	1 502
60	358	2 088	1 284	1 030	2 227	1 216	644
61	.	726	856	1 259	1 781	608	429
62	.	817	1 498	458	742	.	.
63	119	817	642	.	148	.	.
64	.	454	1 076	343	.	.	.
65	.	635	642	.	.	.	.
66	.	181	.	.	148	.	.
67	.	.	428	.	.	.	.
68	.	272	428	.	.	.	.
69	.	181	.	.	.	.	.

asurements 1905—08.

ording to months (relative numbers) and the sum of all months (Year) olute numbers).

e D, Q, $M(C)$, Q, D, V-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
12 273 000 000	4 798 1 000 000	4 366 1 000 000	2 256 1 000 000	5 077 1 000 000	76 243	1 000 000	
							cm
	417	458		394	56	734	20
1 630	3 752	6 184		4 136	286	3 751	21
6 600	10 838	18 552	8 422	11 227	865	11 345	22
20 288	26 052	30 921	18 617	24 424	1 715	22 494	23
38 377	41 684	42 831	28 812	36 833	2 722	35 702	24
50 843	**58 358**	**49 244**	**53 634**	**52 196**	3 683	**48 306**	25
65 265	63 568	54 741	69 149	112 862	5 002	65 606	26
71 784	**60 233**	**57 261**	62 056	**125 270**	5 431	**71 233**	27
76 672	66 069	68 713	**64 716**	115 816	5 859	76 847	28
70 561	77 741	93 678	66 046	*) **91 589**	5 908	77 489	29
74 880	92 330	*) **117 040**	74 911	76 817	6 186	81 136	30
76 917	*) **90 454**	106 963	*) **80 673**	67 362	5 683	*) **74 538**	31
79 117	81 701	69 858	74 024	**57 120**	5 212	68 360	32
70 887	72 530	**44 434**	59 397	44 514	4 576	60 019	33
58 502	**55 857**	28 630	39 893	40 378	3 664	48 057	34
40 007	38 558	19 010	24 823	31 515	2 564	**33 629**	35
31 859	25 844	8 246	19 947	**18 121**	1 903	24 960	36
24 118	15 215	9 162	**15 957**	11 227	1 396	18 310	37
15 237	11 483	8 016	12 855	6 697	958	12 565	38
12 140	7 295	8 704	16 401	7 485	810	10 624	39
11 081	**6 253**	9 849	13 298	4 727	705	9 247	40
9 207	7 920	12 597	15 957	6 500	687	9 011	41
9 452	13 756	12 368	12 855	4 924	772	10 125	42
11 326	8 962	11 681	16 844	4 924	810	10 624	43
9 044	10 004	**14 659**	16 401	**7 682**	884	11 594	44
9 289	**6 253**	11 452	19 060	6 303	915	**12 001**	45
9 859	10 421	13 972	**21 276**	4 727	945	12 395	46
7 578	5 419	9 391	17 730	4 727	825	10 821	47
6 926	3 960	10 078	18 174	3 545	802	10 519	48
6 844	6 669	**8 475**	**14 184**	3 939	822	**10 781**	49
5 215	6 044	8 016	8 865	3 348	699	9 168	50
4 074	5 211	5 497	10 195	2 758	634	8 315	51
3 341	2 501	4 123	4 876	1 576	450	5 902	52
2 770	2 084	4 581	7 092	591	410	5 377	53
2 933	834	3 436	5 319	1 182	326	4 276	54
1 955	2 084	2 749	4 433	1 182	266	3 489	55
1 304	208	3 894	887	788	210	2 754	56
978	208	2 290	1 330	197	180	2 361	57
733	834	2 978	443	197	132	1 731	58
163	.	1 603	443	197	93	1 220	59
81	208	916	.	.	69	905	60
163	208	687	.	.	45	590	61
.	.	687	.	.	24	315	62
.	.	458	.	.	20	262	63
.	.	.	.	.	13	171	64
.	.	687	.	.	13	171	65
.	.	.	.	.	3	39	66
.	.	229	.	.	3	39	67
.	.	.	.	.	5	66	68
.	.	.	.	.	2	26	69

Tab. VIII. English Mark

Area B_1. Analysis of all plaice-samples measured in the three years, arrang (relative a

The numbers printed in heavy type in each column indicate the intervals of length in w

Month	January	February	March	April	May	June	July
Absolute nos.	1 169	1 307	7 822	14 510	6 354	5 401	7 519
Relative »	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000
cm							
18	.	.	.	.	.	.	1 330
19	.	.	.	.	.	.	6 783
20	.	.	.	1 240	.	.	28 461
21	.	.	1 534	5 307	.	926	53 863
22	.	.	9 077	7 788	1 417	1 852	**51 071**
23	.	.	20 711	6 547	472	1 666	56 656
24	23 951	22 953	43 979	14 542	2 361	741	**52 932**
25	35 071	22 188	**47 047**	19 435	4 092	1 852	40 830
26	**45 336**	39 786	43 467	26 120	8 184	2 037	28 594
27	47 047	**32 900**	43 723	**31 495**	11 961	11 664	25 668
28	70 998	35 960	47 814	37 560	21 876	20 552	19 018
29	**94 094**	23 718	**45 641**	47 209	25 338	27 958	21 279
30	85 540	24 484	48 453	**59 407**	**41 863**	**37 771**	24 604
31	87 251	20 658	40 655	49 828	39 345	42 770	38 436
32	*) **51 324**	11 477	40 143	83 942	64 684	48 139	*) **59 848**
33	58 167	9 946	28 382	51 344	**42 178**	40 548	44 687
34	33 361	**8 416**	33 367	*) **72 019**	63 425	**49 620**	74 345
35	18 819	8 416	*) **30 299**	57 409	52 408	47 769	70 089
36	15 397	6 121	26 336	37 078	40 604	35 179	39 234
37	7 699	4 591	21 350	33 218	36 985	31 105	**42 559**
38	3 422	2 295	27 103	38 180	39 975	35 734	36 840
39	.	1 530	25 952	36 182	*) **33 207**	32 772	22 875
40	.	3 826	30 938	28 118	36 040	*) **31 846**	19 683
41	.	9 947	23 012	**21 089**	32 578	28 328	11 970
42	.	13 007	24 546	22 398	37 457	38 141	15 694
43	5 132	16 067	27 103	25 431	37 929	42 029	12 768
44	.	28 309	22 501	23 501	40 290	42 770	**12 103**
45	17 963	37 490	**29 021**	23 087	**36 355**	42 214	14 630
46	20 530	55 088	26 975	20 951	38 401	40 733	11 837
47	35 071	*) **68 095**	24 291	18 608	31 948	**40 178**	12 236
48	**29 939**	63 504	30 299	**17 367**	29 116	36 289	**9 443**
49	41 915	67 330	22 628	14 748	28 171	31 105	6 384
50	37 638	71 155	21 989	15 231	22 506	27 032	9 576
51	29 939	**63 504**	**15 597**	**12 474**	**19 830**	27 032	6 251
52	**14 542**	45 907	15 853	9 235	14 479	20 367	4 655
53	17 108	35 960	10 937	8 890	12 905	16 849	1 995
54	11 976	35 195	**10 995**	5 927	**8 341**	**11 664**	3 325
55	11 976	**25 249**	8 182	4 686	8 971	12 405	2 261
56	**10 265**	25 249	6 648	3 377	8 813	9 813	1 463
57	9 409	18 363	6 392	3 239	6 138	10 183	1 330
58	8 554	**18 363**	5 242	2 481	5 351	5 740	931
59	5 988	11 477	3 196	1 172	3 777	**5 925**	798
60	5 132	5 356	3 707	827	3 777	3 333	266
61	855	2 295	1 790	482	2 833	2 037	133
62	2 566	1 530	1 279	482	1 259	2 037	266
63	.	765	1 406	276	1 102	370	.
64	2 566	765	639	69	315	370	.
65	2 566	.	.	.	157	185	.
66	.	.	.	.	157	.	.
67	.	.	.	.	315	370	.
68	855	765	.	.	157	.	.
69	.	.	.	.	157	.	.
70	.	.	.	.	.	.	.

asurements 1905—08.

:ording to months (relative numbers) and the sum of all months (Year) solute numbers).

he D, Q, $M(C)$, Q, D, V-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
8 472	7 499	3 564	6 413	2 358	72 388		
000 000	1 000 000	1 000 000	1 000 000	1 000 000		1 000 000	
							cm
.	.	.	.	.	10	138	18
.	667	.	2 027	.	69	953	19
472	6 401	.	5 925	.	3 22	4 448	20
1 298	37 871	.	16 061	.	897	12 392	21
1 771	**66 408**	.	18 400	.	1 218	16 826	22
2 243	85 744	.	21 831	.	1 497	20 680	23
5 784	**111 881**	.	28 692	.	2 102	29 037	24
13 574	121 349	.	**26 509**	.	2 258	**31 193**	25
27 974	*) **106 413**	842	21 208	.	2 276	31 442	26
47 450	97 479	6 453	19 180	.	2 508	34 647	27
47 686	62 141	16 835	13 722	.	2 460	33 983	28
60 552	38 672	35 353	21 675	.	2 723	**37 617**	29
78 140	**30 937**	**54 714**	21 051	.	3 252	44 925	30
78 376	29 337	50 224	30 563	424	3 200	44 206	31
92 304	29 604	46 296	**27 756**	1 272	4 078	56 335	32
49 221	29 870	37 598	27 132	2 969	2 827	39 053	33
64 212	26 003	**35 634**	18 712	424	3 573	49 359	34
61 497	19 869	13 749	11 383	.	3 013	*) **41 623**	35
42 847	**14 935**	14 310	11 695	4 665	2 125	29 356	36
42 139	9 735	14 310	7 329	8 058	1 934	26 717	37
38 126	8 801	23 850	9 356	20 780	2 080	28 734	38
34 348	6 401	31 706	13 254	27 142	1 891	26 123	39
25 850	3 600	35 915	16 061	29 262	1 750	24 175	40
22 545	4 267	41 807	17 464	**33 079**	1 511	20 874	41
22 309	**4 134**	*) **42 368**	19 803	40 288	1 689	23 333	42
23 017	5 201	54 714	24 637	34 351	1 840	25 419	43
21 128	4 534	45 174	26 041	41 561	1 771	**24 465**	44
20 184	6 134	49 944	*) **26 353**	**42 833**	1 866	25 778	45
14 164	6 668	37 037	27 756	35 623	1 728	23 871	46
13 102	4 801	34 231	32 902	53 011	1 707	23 581	47
12 394	4 001	**36 476**	38 671	55 980	1 704	23 540	48
8 735	4 401	33 109	37 424	61 069	1 532	21 164	49
8 263	2 800	37 598	40 231	*) **71 247**	1 542	21 302	50
6 492	2 134	30 022	37 268	61 069	1 301	**17 973**	51
4 957	1 467	24 130	**36 332**	52 163	1 067	14 740	52
2 833	1 067	**23 008**	34 305	43 257	904	12 488	53
2 125	1 334	13 468	28 536	**45 377**	739	**10 209**	54
826	400	19 641	33 682	47 922	729	10 071	55
236	1 067	**12 626**	33 058	31 382	607	8 385	56
354	800	10 382	**29 783**	31 382	547	7 557	57
354	400	9 540	20 115	**41 985**	451	6 230	58
118	133	5 892	**17 776**	22 053	315	4 352	59
.	133	7 576	14 970	**22 477**	275	3 799	60
.	.	3 086	10 292	13 147	163	2 252	61
.	.	4 489	8 732	7 634	133	1 837	62
.	.	842	5 458	7 209	80	1 105	63
.	.	1 964	3 586	5 089	56	774	64
.	.	842	2 963	1 696	31	428	65
.	.	561	1 092	848	12	166	66
.	.	1 122	468	.	11	152	67
.	.	281	780	424	10	138	68
.	.	281	.	424	3	41	69
.	.	.	.	424	1	14	70

Tab. IX. English Marke

Area $D_1 + D_2$. Analysis of all plaice-samples measured in the three years, arrange (relative an

The numbers printed in heavy type in each column indicate the intervals of length in whi

Month	January	February	March	April	May	June	July
Absolute nos.	507	1 666	764	548	10 534	11 677	8 716
Relative »	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000	1 000 000
cm							
20	.	.	.	18 248	.	.	918
21	.	.	.	36 496	.	.	3 671
22	.	.	9 162	18 248	.	.	1 950
23	.	.	3 927	10 949	949	.	2 868
24	.	.	6 545	**32 847**	1 709	.	9 981
25	7 890	.	11 780	32 847	2 848	.	13 194
26	35 505	14 406	35 340	82 117	2 943	257	13 768
27	**57 199**	31 212	**60 209**	**74 818**	4 177	343	11 932
28	118 344	44 418	56 283	98 540	4 367	171	13 538
29	**134 123**	**40 816**	47 121	*) **116 788**	2 848	1 028	15 144
30	120 316	52 821	**90 314**	78 467	3 987	2 826	**13 653**
31	*) **145 957**	**69 028**	20 942	21 898	2 278	4 539	13 423
32	**155 819**	76 831	22 251	20 073	4 557	7 793	14 341
33	84 813	73 229	1 309	.	3 038	9 078	11 358
34	**61 144**	76 831	2 618	7 299	6 455	12 075	18 127
35	**55 227**	*) **67 227**	.	.	9 683	13 360	25 585
36	9 862	58 223	.	7 299	8 639	19 954	32 698
37	7 889	48 019	.	20 073	8 828	20 211	**46 580**
38	5 917	48 619	.	25 548	19 366	**27 661**	55 759
39	.	36 014	.	29 197	**19 556**	33 142	58 283
40	.	**16 807**	2 618	9 124	30 567	39 565	65 052
41	.	16 807	11 780	7 299	33 605	42 048	51 514
42	.	14 406	14 398	**10 949**	36 073	**46 930**	*) **40 156**
43	.	9 604	34 031	7 299	**53 446**	53 438	50 481
44	.	9 604	35 340	12 774	59 996	59 947	49 449
45	.	10 204	*) **51 047**	9 124	67 685	73 135	51 514
46	.	9 604	37 958	18 248	65 597	*) **67 140**	39 467
47	.	13 608	69 372	7 299	*) **71 008**	68 939	**39 467**
48	.	12 605	60 209	10 949	87 620	71 765	43 483
49	.	18 007	41 885	10 949	65 217	57 206	34 534
50	.	19 808	**60 209**	10 949	72 337	**63 115**	33 042
51	.	**22 209**	47 121	3 650	**51 072**	44 189	**26 732**
52	.	13 806	17 016	1 825	39 111	36 653	24 782
53	.	21 609	37 958	34 672	35 124	**28 260**	15 718
54	.	**13 806**	**17 016**	21 899	**28 384**	20 553	**14 456**
55	.	12 005	22 251	**23 723**	21 074	16 414	12 620
56	.	6 002	18 325	18 248	15 948	**12 246**	6 769
57	.	9 604	**20 942**	**23 723**	**13 480**	10 020	6 195
58	.	5 402	9 162	9 124	11 771	9 848	5 851
59	.	2 401	9 162	1 825	7 784	5 566	2 983
60	.	2 401	7 853	1 825	9 018	7 194	3 327
61	.	600	1 309	5 474	4 841	3 939	1 606
62	.	600	.	3 650	3 607	2 655	1 377
63	.	.	1 309	1 825	3 133	2 398	1 033
64	.	.	3 927	1 825	2 848	1 627	574
65	.	.	.	.	949	1 028	574
66	.	600	.	.	949	1 028	115
67	.	.	.	.	285	171	229
68	.	.	.	.	759	257	.
69	.	.	.	.	190	.	.
70	.	.	.	.	285	86	115

asurements 1905—08.

ording to months (relative numbers) and the sum of all months (Year)
olute numbers).

ne D, Q, $M(C)$, Q, D, V-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
3 949	3 382	1 187	1 212	969	45 110		
000 000	1 000 000	1 000 000	1 000 000	1 000 000		1 000 000	
							cm
.	.	.	.	.	18	399	20
.	.	.	.	.	52	1 153	21
.	.	.	.	.	34	754	22
.	.	.	.	.	44	975	23
.	.	.	.	.	128	2 838	24
5 065	.	.	.	.	196	4 345	25
6 331	5 914	.	.	.	313	6 939	26
16 460	8 279	4 212	3 300	.	422	9 355	27
31 147	18 037	16 007	.	.	600	13 301	28
38 744	23 359	46 335	8 251	.	707	15 673	29
68 878	29 273	**76 664**	9 901	.	929	20 594	30
67 865	**19 219**	59 815	4 950	.	821	18 200	31
73 183	32 821	**58 972**	15 677	.	988	**21 902**	32
31 400	22 768	27 801	15 677	.	656	14 542	33
40 417	49 083	62 342	42 904	5 160	989	21 924	34
24 563	**67 711**	58 130	**42 904**	11 352	1 079	23 919	35
28 108	40 509	38 753	59 406	40 248	1 120	24 828	36
24 057	61 502	32 013	**56 105**	**89 783**	1 326	29 395	37
31 147	65 937	*) **45 493**	83 333	**122 807**	1 731	**38 373**	38
35 705	54 110	25 274	105 610	154 799	1 809	40 102	39
35 199	*) **59 728**	43 808	*) **81 683**	*) **117 647**	1 992	44 159	40
28 108	46 718	45 493	61 881	87 719	1 818	40 301	41
29 375	52 336	47 178	51 155	65 015	1 793	39 747	42
25 829	55 293	62 342	47 033	**65 015**	2 156	47 794	43
28 615	**46 126**	**34 541**	58 580	58 823	2 351	*) **49 900**	44
41 530	41 396	36 226	**40 429**	44 376	2 516	55 775	45
36 971	36 665	32 013	37 954	**38 184**	2 265	50 211	46
33 679	28 681	23 589	33 927	21 672	2 285	50 654	47
39 757	29 864	**29 486**	27 228	18 576	2 557	56 684	48
27 602	**16 558**	14 322	**14 851**	**15 480**	1 939	**42 984**	49
34 946	18 332	27 801	23 102	16 512	2 149	47 639	50
23 044	18 037	**16 849**	13 201	13 416	1 563	34 649	51
26 589	**8 575**	8 425	9 076	3 096	1 251	27 732	52
11 902	9 757	10 952	**8 251**	3 096	1 027	**22 767**	53
13 168	5 618	4 212	11 551	3 096	806	17 867	54
13 168	5 322	5 897	5 776	1 032	661	**14 653**	55
5 824	4 731	2 527	8 251	1 032	457	10 131	56
3 798	2 365	2 527	4 125	1 032	390	8 646	57
4 305	4 140	.	6 601	.	350	7 759	58
4 558	2 365	.	4 125	.	216	4 788	59
3 039	2 957	.	5 776	1 032	249	5 520	60
2 279	1 478	.	2 475	.	133	2 948	61
760	591	.	1 650	.	91	2 017	62
1 013	1 183	.	1 650	.	82	1 818	63
506	1 478	.	.	.	65	1 441	64
1 013	.	.	825	.	32	709	65
.	296	.	.	.	25	554	66
.	.	.	.	.	7	155	67
.	296	.	.	.	11	244	68
.	296	.	825	.	4	87	69
253	296	.	.	.	7	155	70

Tab. X. English Mark

Analysis of all plaice-samples measured from all areas, according to mont

The numbers printed in heavy type in each column indicate the intervals of length in wi

Month	January	February	March	April	May	June	July
Absolute nos.	84 670	81 833	133 963	146 414	148 860	172 228	139 536
Relative »	.	.	.	.	.	.	.
cm							
15	.	.	.	22	.	.	.
16	.	.	.	106	7	.	.
17	40	123	369	308	551	554	322
18	557	1 316	1 986	1 683	1 553	1 538	785
19	1 212	2 650	5 723	4 821	4 165	3 391	1 771
20	1 790	**4 959**	**10 036**	**9 364**	8 446	7 930	4 797
21	2 035	5 934	12 477	12 608	**11 834**	**13 105**	**7 870**
22	**3 410**	**6 023**	**14 957**	**15 127**	**14 244**	**18 506**	11 704
23	5 219	5 694	15 913	16 617	14 851	19 456	**12 578**
24	5 861	5 459	*) **15 015**	*) **15 479**	15 202	17 750	12 366
25	**5 866**	5 086	12 139	13 728	*) **13 186**	*) **14 290**	10 623
26	5 768	*) **4 415**	9 949	12 714	12 787	13 014	*) **10 281**
27	5 939	4 163	**7 948**	**10 310**	10 904	10 849	8 466
28	*) **6 008**	3 572	5 972	8 639	**9 437**	9 709	7 882
29	5 746	3 531	4 261	6 532	7 441	**7 993**	7 279
30	5 641	3 460	3 131	**5 080**	6 132	6 942	6 847
31	5 465	3 301	**2 503**	3 848	**4 553**	5 393	**6 249**
32	**4 874**	**3 361**	2 217	**2 717**	3 637	4 470	5 718
33	4 205	3 089	1 679	1 852	2 422	**3 113**	4 117
34	3 469	2 816	**1 444**	1 418	**1 718**	2 541	3 412
35	2 675	2 546	1 256	1 063	1 256	1 917	2 675
36	**1 966**	1 960	1 080	661	845	1 607	**2 125**
37	1 494	**1 564**	915	457	655	**1 202**	1 862
38	1 003	1 186	630	329	526	985	1 552
39	**788**	878	536	282	352	908	1 431
40	674	**783**	399	197	363	843	**1 280**
41	569	749	356	74	293	668	1 016
42	469	576	239	71	246	618	729
43	336	486	195	47	218	545	732
44	255	379	122	32	177	456	566
45	228	297	92	41	187	396	471
46	172	205	84	16	135	283	411
47	162	231	59	22	150	260	338
48	111	194	57	23	101	200	280
49	127	175	38	19	86	181	258
50	98	157	38	13	54	157	205
51	78	90	20	12	40	123	163
52	71	75	26	12	38	94	130
53	57	55	17	12	22	75	100
54	38	56	19	6	24	50	61
55	39	40	9	12	6	35	35
56	29	32	7	4	5	18	23
57	32	36	9	8	7	12	5
58	27	20	7	11	.	18	10
59	19	18	7	1	.	12	5
60	10	19	7	8	2	6	1
61	12	17	2	1	.	4	.
62	4	14	7	4	1	3	2
63	7	8	4	1	.	3	1
64	5	12	3	1	1	2	.
65	4	5	.	.	.	.	1
66	2	8	2	.	.	2	.
67	2	5	2	1	.	.	1
68	1	4	.	.	.	1	.
69	1	1	.	.	.	.	.

easurements 1905—06.

solute numbers) and the sum of all months (absolute and relative numbers).

the D, Q, $M(C)$, Q, D, V-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
139 424	143 812	123 327	140 816	97 689	1 552 572	1 000 000	
							cm
					22	14	15
		23			136	88	16
		27	1		2 295	1 478	17
	18	538	1 138	677	11 789	7 593	18
105	306	1 870	2 998	1 980	30 992	19 962	19
2 134	2 678	4 647	5 085	2 531	64 397	41 478	20
4 876	5 624	**8 112**	**6 552**	2 930	93 957	**60 517**	21
8 459	**9 988**	12 429	9 232	**4 972**	129 051	83 121	22
10 996	12 800	**16 467**	**12 682**	7 207	150 480	**96 924**	23
12 683	**15 436**	*) **18 968**	15 295	**8 679**	158 193	101 892	24
12 789	14 541	17 053	15 662	9 359	144 322	*) **92 957**	25
12 066	*) **12 911**	**14 599**	*) **14 879**	9 782	133 165	85 771	26
) **10 886**	11 287	10 186	13 095	*) **8 744**	112 777	72 639	27
10 204	9 984	**6 947**	**10 377**	7 623	96 354	62 061	28
9 148	8 591	4 350	8 174	6 467	79 513	**51 214**	29
8 236	**7 483**	**2 693**	6 673	**5 686**	68 004	43 801	30
6 629	5 467	1 826	4 846	4 755	54 835	35 319	31
5 852	6 016	1 000	**3 621**	4 079	47 562	30 634	32
4 430	3 733	545	2 613	**2 934**	34 732	**22 371**	33
3 741	**3 157**	273	**1 971**	2 239	28 199	18 163	34
2 738	2 379	294	1 376	1 697	21 872	14 088	35
2 199	1 831	100	1 137	**1 146**	16 657	**10 729**	36
1 827	1 569	106	783	935	13 369	8 611	37
1 520	**1 248**	65	535	579	10 158	6 543	38
1 340	1 061	51	408	411	8 446	5 440	39
1 160	930	33	318	392	7 372	4 748	40
876	723	31	267	288	5 910	3 807	41
717	627	30	197	283	4 802	3 093	42
676	654	23	167	205	4 284	2 759	43
525	540	17	126	167	3 362	2 165	44
502	480	8	104	140	2 946	1 897	45
440	402	4	68	131	2 351	1 514	46
312	301	2	66	109	2 012	1 296	47
267	242	9	67	94	1 645	1 060	48
242	202		53	105	1 486	957	49
232	176	1	63	90	1 284	827	50
157	126		24	37	870	560	51
126	100		34	48	754	486	52
88	80		27	32	565	364	53
79	50		22	39	444	286	54
50	30		16	22	294	189	55
41	19		16	14	208	134	56
15	11		9	18	162	104	57
15	6		9	12	135	87	58
14	2		9	13	100	64	59
12	3		8	7	83	53	60
7			4	17	64	41	61
4			4	3	46	30	62
6			5	3	38	24	63
1				2	27	17	64
2				2	14	9	65
				3	17	11	66
					11	7	67
				1	7	4	68
					2	1	69

Tab. XI. English Mark

Analysis of all plaice-samples measured from all areas, according to mont

The numbers printed in heavy type indicate the intervals of length, within wh

Month	January	February	March	April	May	June	July
Absolute nos.	100 201	116 201	166 726	196 665	203 636	192 421	171 271
Relative »	.	.	.	.	.	.	.
cm							
17	.	.	12	9	3	.	.
18	139	278	183	312	321	328	267
19	817	1 157	1 260	2 095	1 759	1 346	1 224
20	2 204	2 917	3 849	5 414	6 529	4 650	3 289
21	4 121	4 903	7 341	**12 155**	**13 660**	9 663	5 877
22	**6 338**	**6 405**	**11 506**	16 838	19 721	**15 145**	**8 559**
23	7 548	7 691	14 745	**18 063**	**21 496**	**18 156**	10 741
24	**8 026**	**8 927**	**17 022**	18 780	23 074	21 658	**13 814**
25	7 936	8 847	17 006	18 287	*) **20 193**	20 053	15 649
26	7 289	8 486	*) **14 592**	*) **14 842**	16 246	*) **16 824**	14 800
27	*) **6 733**	7 860	12 768	13 494	13 853	14 102	*) **13 552**
28	6 855	*) **7 781**	11 743	12 646	13 383	13 196	13 619
29	5 874	6 902	9 658	10 750	**10 903**	**11 163**	12 032
30	5 680	6 754	**8 833**	**9 983**	9 638	10 141	11 921
31	4 474	5 608	6 139	7 346	6 702	7 695	**9 731**
32	**4 049**	**5 018**	5 060	6 398	4 836	5 726	8 573
33	3 018	4 039	4 603	4 560	**3 169**	3 545	5 594
34	2 617	3 473	2 941	4 173	2 332	**2 710**	4 774
35	2 152	2 656	**2 093**	**3 156**	1 596	1 944	**3 271**
36	1 666	2 088	1 575	2 322	1 026	1 433	2 370
37	1 406	1 652	1 262	1 963	845	990	1 730
38	**1 338**	**1 454**	1 189	1 672	821	775	**1 497**
39	1 125	1 197	953	1 358	688	653	1 095
40	1 012	967	936	1 134	**787**	630	905
41	813	766	902	**956**	738	597	743
42	703	743	799	889	776	**656**	686
43	758	698	**961**	908	921	767	687
44	**731**	687	979	897	866	798	654
45	640	**658**	931	762	851	865	623
46	515	625	835	676	800	840	511
47	455	625	779	597	744	796	468
48	486	594	792	561	805	832	462
49	379	562	588	464	613	632	354
50	404	543	581	425	644	659	343
51	313	466	473	391	503	533	209
52	271	395	384	303	341	417	171
53	292	325	322	272	326	324	111
54	206	289	230	195	249	235	96
55	157	259	217	159	184	217	70
56	138	199	169	130	154	172	52
57	100	161	143	105	131	140	49
58	90	141	105	80	111	118	35
59	85	98	83	37	67	80	17
60	63	92	63	38	74	84	20
61	54	55	36	26	54	41	9
62	41	49	31	14	33	31	6
63	31	39	20	11	24	24	4
64	22	24	16	9	17	18	5
65	11	16	8	2	11	5	1
66	12	11	2	2	6	7	1
67	3	10	3	1	4	4	.
68	5	7	4	.	3	2	.
69	4	4	.	4	2	.	.
70	2	.	1	.	3	1	.
76	.	.	.	1	.	.	.

surements 1906—07.

olute numbers) and the sum of all months (absolute and relative numbers).

e D, Q, $M(C)$, Q, D, V-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
134 884	140 700	125 427	106 231	121 294	1 775 658	1 000 000	
							cm
.	.	14	26	.	64	36	17
157	114	127	224	234	2 684	1 512	18
627	936	844	768	1 103	13 936	7 848	19
1 961	2 638	2 896	2 356	3 893	42 596	23 988	20
3 693	5 651	5 419	4 636	6 419	83 538	47 046	21
5 961	**9 109**	**8 558**	**7 307**	**9 237**	124 684	**70 219**	22
7 383	11 992	10 972	10 064	**10 911**	149 762	84 342	23
8 768	**13 926**	**13 154**	**11 699**	12 628	171 476	**96 571**	24
9 837	13 721	12 573	10 896	12 644	167 642	94 412	25
10 849	11 348	*) **10 554**	*) **8 467**	*) **10 053**	144 350	*) **81 294**	26
10 589	*) **10 040**	9 118	7 229	8 777	128 115	72 151	27
10 210	9 688	8 016	6 477	7 930	121 544	68 450	28
9 253	9 171	6 652	5 436	6 128	103 922	58 526	29
9 506	**8 337**	**5 828**	**4 614**	**5 158**	96 393	**54 286**	30
8 185	6 690	4 336	3 235	3 890	74 031	41 692	31
7 795	5 486	3 823	2 558	2 946	62 268	35 068	32
5 226	3 590	2 997	1 890	2 391	43 622	24 567	33
4 934	3 376	2 473	1 470	1 855	37 128	20 909	34
3 692	**2 315**	1 883	1 255	1 439	27 452	15 460	35
2 610	1 599	1 620	979	1 013	20 301	**11 433**	36
1 966	1 242	**1 459**	979	**940**	16 434	9 255	37
1 791	1 291	1 467	979	1 015	15 289	8 610	38
1 455	1 005	1 377	1 046	962	12 914	7 273	39
1 034	**826**	1 275	977	915	11 398	6 419	40
870	780	1 059	**906**	997	10 127	5 703	41
795	678	**883**	813	804	9 225	**5 195**	42
874	705	981	859	892	10 011	5 638	43
848	667	821	828	**863**	9 639	5 428	44
775	609	722	768	779	8 983	5 059	45
575	533	539	707	667	7 823	4 406	46
557	477	503	**629**	595	7 225	4 069	47
557	477	483	741	606	7 396	4 165	48
385	340	358	589	502	5 766	3 247	49
346	340	393	613	483	5 774	3 252	50
237	229	278	490	342	4 464	2 514	51
180	168	212	410	250	3 502	1 972	52
125	124	224	445	195	3 085	1 737	53
91	99	145	349	190	2 374	1 337	54
56	81	103	317	137	1 957	1 102	55
29	71	76	297	104	1 591	896	56
30	46	54	233	84	1 276	719	57
23	46	45	159	95	1 048	590	58
18	29	29	131	54	728	410	59
4	31	30	116	52	667	376	60
5	20	7	80	42	429	242	61
6	14	18	66	25	334	188	62
3	11	4	46	23	240	135	63
3	13	9	30	17	183	103	64
3	3	7	22	7	96	54	65
3	5	2	9	2	62	35	66
2	3	3	5	2	40	22	67
.	2	1	5	1	30	17	68
1	3	3	1	1	23	3	69
1	5	.	.	2	16	9	70
.	.	.	.	.	1	1	76

Tab. XII. English Mark

Analysis of all plaice-samples measured from all areas, according to mont

The numbers printed in heavy type indicate the intervals of length, within wh

Month	January	February	March	April	May	June	July
Absolute nos.	116 804	104 058	134 779	152 758	142 963	154 881	139 167
Relative »	.	.	.	.	.	.	.
cm							
16	.	.	8	6	.	.	.
17	.	.	109	6	.	29	.
18	69	91	585	259	354	377	295
19	384	685	1 811	1 220	1 427	1 466	1 078
20	1 338	2 369	4 428	4 078	3 828	4 346	3 078
21	3 152	4 687	**7 172**	8 267	7 956	7 603	5 018
22	5 697	**7 038**	10 802	**12 399**	**11 174**	**10 804**	**7 371**
23	**7 667**	7 949	**11 953**	**14 749**	**12 670**	12 381	8 738
24	9 292	**8 647**	12 448	16 051	13 935	**14 542**	**10 441**
25	**10 769**	8 866	12 728	15 800	13 596	14 563	11 612
26	10 158	9 151	*) **10 895**	*) **12 561**	*) **11 797**	*) **12 035**	10 802
27	9 314	*) **6 606**	8 843	9 797	10 142	11 372	10 530
28	*) **8 033**	5 819	7 778	9 204	9 023	11 002	*) **9 488**
29	7 767	5 154	7 177	8 428	7 649	10 764	8 685
30	7 416	4 901	**6 805**	**7 656**	**7 408**	**9 229**	7 973
31	5 823	4 111	5 377	6 392	6 141	7 096	7 009
32	**5 476**	**4 014**	4 718	6 462	6 215	6 776	**7 428**
33	4 030	3 255	3 141	3 696	3 470	4 127	4 990
34	3 363	2 930	2 722	**3 835**	**3 288**	**3 753**	5 650
35	2 549	2 345	**2 140**	2 803	2 264	2 654	4 441
36	1 887	1 844	1 585	1 528	1 298	1 592	**2 414**
37	**1 485**	1 489	1 145	**1 193**	943	**1 238**	2 311
38	1 189	1 341	1 206	1 192	827	862	1 808
39	924	**1 099**	1 009	949	**584**	608	**1 170**
40	862	984	919	649	454	491	873
41	682	759	**740**	400	380	363	642
42	722	723	707	376	336	376	694
43	**671**	708	693	331	402	310	565
44	706	741	662	323	485	388	602
45	688	**659**	630	303	500	531	679
46	677	638	562	246	505	442	454
47	572	579	496	227	549	435	417
48	559	675	485	222	601	425	397
49	496	546	382	215	525	371	318
50	555	542	348	210	489	402	302
51	344	414	274	158	357	260	178
52	274	342	236	99	284	205	168
53	258	318	195	74	230	141	93
54	181	252	201	84	176	115	119
55	157	186	145	66	153	102	100
56	135	136	100	50	125	59	64
57	94	106	81	42	92	75	60
58	94	83	80	34	91	43	38
59	52	88	50	43	62	33	27
60	71	49	56	23	70	37	16
61	49	37	31	15	33	19	12
62	34	23	35	13	23	15	7
63	18	24	15	6	17	7	5
64	15	16	25	3	17	2	3
65	22	14	19	.	2	10	3
66	14	5	7	3	7	5	.
67	9	8	10	3	1	.	1
68	3	6	7	.	6	.	.
69	6	3	1	1	2	.	.
70	1	1	2	.	.	.	1
71	1	2	.	.	.	.	.

asurements 1907—08.

solute numbers) and the sum of all months (absolute and relative numbers).

he D, Q, $M(C)$, Q, D, V-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
141 696	146 652	134 148	110 521	119 049	1 597 468	1 000 000	
							cm
					14	9	16
15					159	100	17
250	73	4	40	26	2 423	1 517	18
1 152	509	280	308	253	10 573	6 619	19
3 602	2 069	1 518	1 304	1 065	33 023	20 672	20
5 844	5 398	3 709	3 408	3 080	65 294	40 873	21
8 028	**8 962**	7 542	**6 199**	5 823	101 839	**63 750**	22
9 026	11 673	**10 549**	8 909	**8 554**	124 818	78 135	23
10 571	**13 763**	**13 029**	**11 316**	10 868	144 903	**90 708**	24
11 316	12 692	13 819	11 865	**12 075**	149 701	93 711	25
10 517	11 780	11 367	9 736	10 992	131 791	82 500	26
10 231	*) **11 098**	*) **10 478**	*) **8 495**	*) **9 897**	116 803	*) **73 118**	27
*) **9 838**	10 992	10 424	7 366	8 631	107 598	67 355	28
9 542	9 868	9 576	6 312	7 129	98 051	61 379	29
9 482	8 661	**9 310**	5 835	6 620	91 296	57 150	30
8 134	**7 158**	2 882	**4 890**	**5 502**	74 515	**46 646**	31
8 111	6 940	5 382	4 815	5 228	71 564	44 798	32
5 089	4 189	3 266	3 021	3 365	45 639	28 570	33
5 277	4 693	2 813	2 664	3 139	44 127	27 623	34
4 027	**3 678**	**1 987**	1 743	2 150	32 781	**20 521**	35
2 163	1 931	1 225	1 127	1 459	20 053	12 553	36
2 061	2 211	957	**848**	1 086	16 967	10 621	37
1 556	**2 067**	936	827	**1 012**	14 823	9 279	38
930	1 180	824	672	890	10 839	6 785	39
659	968	818	621	831	9 129	**5 715**	40
420	606	765	549	753	7 059	4 419	41
499	628	**687**	573	864	7 185	4 498	42
402	446	812	658	916	6 914	4 328	43
406	412	731	663	984	7 103	4 446	44
473	397	700	**707**	**917**	7 184	4 497	45
331	262	592	665	673	6 047	3 785	46
350	308	573	691	710	5 907	3 698	47
296	250	521	648	689	5 768	3 611	48
217	175	356	583	510	4 694	2 938	49
220	183	389	555	564	4 759	2 979	50
140	82	316	414	375	3 312	2 073	51
116	78	225	320	332	2 679	1 677	52
71	63	161	279	275	2 158	1 351	53
82	61	140	201	203	1 815	1 136	54
88	41	113	157	153	1 461	915	55
38	25	79	127	117	1 055	660	56
28	21	79	84	76	838	525	57
27	15	62	87	80	734	459	58
16	16	26	55	50	518	324	59
17	5	30	59	46	479	300	60
12	6	30	40	23	307	192	61
3	8	24	26	24	235	147	62
10	4	9	15	18	148	93	63
5	5	12	11	9	123	77	64
7	2	10	12	4	105	66	65
		4	7	4	56	35	66
		5	3		40	25	67
		1	4	3	30	19	68
			3		16	10	69
1		1	2	1	10	6	70
			2	1	6	4	71

Tab. XIII. English Marke

Analysis of all plaice-samples measured from all areas (sum of three years (absolute an

The numbers printed in heavy type indicate the intervals of length, within whi

Month	January	February	March	April	May	June	July
Absolute nos.	301 675	302 092	435 468	495 829	495 459	519 530	4 449 974
Relative »	.	.	.	.	.	.	.
cm							
15	.	.	.	22	.	.	.
16	.	.	8	112	7	.	.
17	40	123	490	323	554	583	322
18	765	1 685	2 754	2 254	2 228	2 243	1 347
19	2 413	4 492	8 794	8 136	7 351	6 203	4 073
20	5 332	10 245	18 313	18 856	18 803	16 926	11 164
21	9 308	**15 524**	**26 990**	**33 030**	**33 450**	**30 371**	18 765
22	**15 445**	19 466	37 265	44 364	45 139	44 455	**27 634**
23	20 434	21 334	**42 611**	**49 429**	**49 017**	**49 993**	32 057
24	**23 179**	**23 033**	44 485	50 310	52 211	53 950	**36 621**
25	24 571	22 799	*) **41 873**	*) **47 815**	46 975	48 906	37 884
26	23 215	22 052	35 436	40 117	*) **40 830**	*) **41 873**	35 883
27	21 986	*) **18 629**	29 559	33 601	34 899	36 323	*) **32 548**
28	*) **20 896**	17 172	25 493	30 489	31 843	33 907	30 989
29	19 387	15 587	**21 096**	**25 710**	**25 993**	**29 920**	27 996
30	18 737	15 115	18 769	22 719	23 178	26 312	26 741
31	15 762	13 020	14 019	17 586	17 396	20 184	**22 989**
32	**14 399**	**12 393**	11 995	15 577	14 688	16 972	21 718
33	11 253	10 383	8 423	**10 108**	**9 061**	10 785	14 701
34	9 449	9 219	**7 107**	9 426	7 338	**9 004**	13 836
35	7 376	7 547	5 489	7 022	5 116	6 515	**10 387**
36	5 519	5 892	4 240	**4 511**	3 169	4 632	6 909
37	**4 385**	4 705	3 322	3 613	**2 443**	3 430	5 903
38	3 530	**3 981**	3 025	3 193	2 174	**2 622**	4 857
39	2 837	3 174	**2 498**	2 589	1 624	2 169	**3 696**
40	2 548	2 734	2 254	1 980	1 604	1 964	3 058
41	2 064	2 274	1 998	1 430	1 411	1 628	2 401
42	**1 894**	2 042	1 745	1 336	1 358	1 650	2 109
43	1 765	1 892	1 849	1 286	1 541	1 622	1 984
44	1 692	**1 807**	1 763	1 252	1 528	1 642	1 822
45	1 556	1 614	1 653	1 106	1 538	1 792	1 773
46	1 364	1 468	1 481	938	1 440	1 565	1 376
47	1 189	1 435	1 334	846	1 443	1 491	1 223
48	1 156	1 463	1 334	806	1 507	1 457	1 139
49	1 002	1 283	1 008	698	1 224	1 184	930
50	1 057	1 242	967	648	1 187	1 218	850
51	735	970	767	561	900	916	550
52	616	812	646	414	663	716	469
53	607	698	534	358	578	540	304
54	425	597	450	285	449	400	276
55	353	485	371	237	343	354	205
56	302	367	276	184	284	249	139
57	226	303	233	155	230	227	114
58	211	244	192	125	202	179	83
59	156	204	140	81	129	125	49
60	144	160	126	69	146	127	37
61	115	109	69	42	87	64	21
62	79	86	73	31	57	49	15
63	56	71	39	18	41	34	10
64	42	52	44	13	35	22	8
65	37	35	27	2	13	15	5
66	28	24	11	5	13	14	1
67	14	23	15	5	5	4	2
68	9	17	11	.	9	3	.
69	11	8	1	5	4	.	.
70	3	1	3	1	3	1	1
71	1	2	.	.	.	.	
76	.	.	.	1	.	.	.

asurements 1905—08.

ording to months (absolute numbers) and the sum of all months tive numbers).

e D, Q, $M(C)$, Q, D, V-values of the series. *) Interval of the median (central value).

August	September	October	November	December	Total (Year)	Total (Year)	
16 004	431 164	382 902	357 568	338 032	4 925 698	1 000 000	
							cm
					22	4	15
		23			150	30	16
15		41	27		2 518	511	17
407	205	669	1 402	937	16 896	3 430	18
1 884	1 751	2 994	4 074	3 336	55 501	11 268	19
7 697	7 385	9 061	8 745	7 489	140 016	28 426	20
14 413	16 673	17 240	14 596	12 429	242 789	49 290	21
22 448	**28 059**	**28 529**	**22 738**	**20 032**	355 574	**72 189**	22
27 405	36 465	**37 988**	31 655	26 672	425 060	**86 295**	23
32 022	**43 125**	45 151	**38 310**	**32 175**	474 572	96 347	24
33 942	40 954	43 445	38 423	34 078	461 665	93 727	25
33 432	36 039	*) **36 520**	*) **33 082**	30 827	409 306	*) **83 097**	26
31 706	*) **32 425**	29 782	28 819	*) **27 418**	357 695	72 619	27
30 252	30 664	25 387	24 220	24 184	325 496	66 081	28
27 943	27 630	**20 578**	19 922	19 724	281 486	57 146	29
27 224	**24 481**	17 831	**17 122**	**17 464**	255 693	**51 910**	30
22 948	19 315	13 044	12 971	14 147	203 381	41 290	31
21 758	18 442	10 205	10 994	12 253	181 394	36 826	32
14 745	11 512	**6 808**	7 524	8 690	123 993	25 173	33
13 952	11 226	5 559	6 105	7 233	109 454	22 221	34
10 457	**8 372**	4 164	**4 374**	**5 286**	82 105	**16 669**	35
6 972	5 361	2 945	3 243	3 618	57 011	11 574	36
5 854	5 022	2 522	2 610	2 961	46 770	9 495	37
4 867	4 606	2 468	2 341	2 606	40 270	8 175	38
3 725	**3 246**	**2 252**	2 126	2 263	32 199	**6 537**	39
2 853	2 724	2 126	1 916	2 138	27 899	5 664	40
2 166	2 109	1 855	1 722	2 038	23 096	4 689	41
2 011	1 933	1 600	**1 583**	**1 951**	21 212	4 306	42
1 952	1 805	1 816	1 684	2 013	21 209	4 306	43
1 779	1 619	1 569	1 617	2 014	20 104	4 081	44
1 750	1 486	1 430	1 579	1 836	19 113	3 880	45
1 346	1 197	1 135	1 440	1 471	16 221	3 293	46
1 219	1 086	1 078	1 386	1 414	15 144	3 074	47
1 120	969	1 013	1 456	1 389	14 809	3 006	48
844	717	714	1 225	1 117	11 946	2 425	49
798	699	783	1 231	1 137	11 817	2 399	50
534	437	594	928	754	8 646	1 755	51
422	346	437	764	630	6 935	1 408	52
284	267	385	751	502	5 808	1 179	53
252	210	285	572	432	4 633	941	54
194	152	216	490	312	3 712	754	55
108	115	155	440	235	2 854	579	56
73	78	133	326	178	2 276	462	57
65	67	107	255	187	1 917	389	58
48	47	55	195	117	1 346	273	59
33	39	60	183	105	1 229	250	60
24	26	37	124	82	800	162	61
13	22	42	96	52	615	125	62
19	15	13	66	44	426	86	63
9	18	21	41	28	333	67	64
12	5	17	34	13	215	44	65
3	5	6	16	9	135	27	66
2	3	8	8	2	91	18	67
	2	2	9	5	67	14	68
1	3	3	4	1	41	8	69
2	**5**	1	2	3	26	5	70
			2	1	6	1	71
					1	0.2	76

Tab. XIV. English Market-Measurements.

Analysis by length and weight of all market-samples measured from the North Sea. Year I. October 1905—06.

Intervals of the 6 principal values in heavy type. Aver. length (*Al*) . . = 27.04 cm. Aver. weight (*Aw*) = 220.2 gm.

	Numbers			Calculated weight kg.			
	Absolute 1 552 572	Relative 1 000 000	Summation Series	Absolute 341 894	Relative 100 000	Summation Series	
cm							cm
15	22	14	14	0.8	0	0	15
16	136	88	102	6.1	2	2	16
17	2 295	1 478	1 580	123.9	36	38	17
18	11 789	7 593	9 173	741.4	217	255	18
19	30 992	19 962	29 135	2 293.4	671	926	19
20	64 397	41 478	70 613	5 538.1	1 620	2 546	20
21	93 957	60 517	**131 130**	9 301.7	2 721	5 267	21
22	129 051	83 121	214 251	14 711.8	4 303	9 570	22
23	150 480	96 923	**311 174**	19 562.4	5 722	**15 292**	23
24	158 193	101 891	413 065	23 254.4	6 802	22 094	24
25	144 322	92 957	*) **506 022**	23 957.5	7 007	**29 101**	25
26	133 165	85 771	591 793	24 768.7	7 245	36 346	26
27	112 777	72 639	664 432	23 457.6	6 861	43 207	27
28	96 354	62 061	726 493	22 257.8	6 510	49 717	28
29	79 513	51 214	**777 707**	20 434.8	5 977	*) **55 694**	29
30	68 004	43 801	821 508	19 313.1	5 649	61 343	30
31	54 835	35 319	856 827	17 163.4	5 020	66 363	31
32	47 562	30 634	887 461	16 313.8	4 772	71 135	32
33	34 732	22 371	**909 832**	13 059.2	3 820	74 955	33
34	28 199	18 163	927 995	11 589.8	3 390	**78 345**	34
35	21 872	14 088	**942 083**	9 779.8	2 860	81 205	35
36	16 657	10 729	952 812	8 095.3	2 368	83 573	36
37	13 369	8 611	961 423	7 045.5	2 061	85 634	37
38	10 158	6 543	967 966	5 800.2	1 696	87 330	38
39	8 446	5 440	973 406	5 202.7	1 522	88 852	39
40	7 372	4 748	978 154	4 895.0	1 432	**90 284**	40
41	5 910	3 807	981 961	4 225.6	1 236	91 520	41
42	4 802	3 093	985 054	3 687.9	1 079	92 599	42
43	4 284	2 759	987 813	3 525.7	1 031	93 630	43
44	3 362	2 165	989 978	2 961.9	863	94 493	44
45	2 946	1 897	991 875	2 775.1	812	**95 305**	45
46	2 351	1 514	993 389	2 362.8	691	95 996	46
47	2 012	1 296	994 685	2 156.9	631	96 627	47
48	1 645	1 060	995 745	1 876.9	549	97 176	48
49	1 486	957	996 702	1 702.6	498	97 674	49
50	1 284	827	997 529	1 653.8	484	98 158	50
51	870	560	998 089	1 188.4	348	98 506	51
52	754	486	998 575	1 091.0	319	98 825	52
53	565	364	998 939	864.8	253	99 078	53
54	444	286	999 225	718.8	210	99 288	54
55	294	189	999 414	502.7	147	99 435	55
56	208	134	999 548	375.2	110	99 545	56
57	162	104	999 652	308.0	90	99 635	57
58	135	87	999 739	270.3	79	99 714	58
59	100	64	999 803	210.6	62	99 776	59
60	83	53	999 856	183.8	54	99 830	60
61	64	41	999 897	148.9	44	99 874	61
62	46	30	999 927	112.3	33	99 907	62
63	38	24	999 951	97.3	28	99 935	63
64	27	17	999 968	72.4	21	99 956	64
65	14	9	999 977	39.3	11	99 967	65
66	17	11	999 988	50.0	15	99 982	66
67	11	7	999 995	33.8	10	99 992	67
68	7	4	999 999	22.5	6	99 998	68
69	2	1	1000 000	6.7	2	100 000	69

Tab. XV. English Market-Measurements.

Analysis by length and weight of all market-samples measured from the North Sea. Year II. October 1906—07.

Intervals of the 6 principal values in heavy type. Aver. length (*Al*) . . = 28.47 cm. Aver. weight (*Aw*) = 271.5 gm.

	Numbers			Calculated weight kg.			Logarithm of the numbers	
	Absolute 1 775 658	Relative 1 000 000	Summation series	Absolute 482 063	Relative 100 000	Summation series		
cm								cm
17	64	36	36	3.5	1	1	1.806	17
18	2 684	1 512	1 548	169.1	35	36	3.429	18
19	13 936	7 848	9 396	1 031.3	214	250	4.144	19
20	42 596	23 988	33 384	3 663.3	760	1 010	4.629	20
21	83 538	47 046	80 430	8 270.3	1 716	2 726	4.922	21
22	124 684	70 219	**150 649**	14 214.0	2 949	5 675	5.096	22
23	149 762	84 342	234 991	19 469.1	4 039	9 714	5.175	23
24	171 476	96 571	**331 562**	25 207.0	5 229	**14 943**	5.234	24
25	167 642	94 412	425 974	27 828 6	5 773	20 716	5.224	25
26	144 350	81 294	*) **507 268**	26 849.1	5 570	**26 286**	5.159	26
27	128 115	72 151	579 419	26 647.9	5 528	31 814	5.108	27
28	121 544	68 450	647 869	28 076.7	5 824	37 638	5.065	28
29	103 922	58 526	706 395	26 708.0	5 540	43 178	5.017	29
30	96 393	54 286	**760 681**	27 375 6	5 679	48 857	4.984	30
31	74 031	41 692	802 373	23 171.7	4 807	*) **53 664**	4.869	31
32	62 268	35 068	837 441	21 457.9	4 451	58 115	4.794	32
33	43 622	24 567	862 008	16 401.9	3 402	61 517	4.640	33
34	37 128	20 909	882 917	15 259.6	3 165	64 682	4.570	34
35	27 452	15 460	898 377	12 271.0	2 545	67 227	4.439	35
36	20 301	11 433	**909 810**	9 866.3	2 047	69 274	4.308	36
37	16 434	9 255	919 065	8 660.7	1 797	71 071	4.216	37
38	15 289	8 610	927 675	8 730.0	1 811	72 882	4.184	38
39	12 914	7 273	934 948	7 955.0	1 650	74 532	4.111	39
40	11 398	6 419	941 367	7 568.3	1 570	**76 102***	4.057	40
41	10 127	5 703	947 070	7 240.8	1 502	77 604	4.005	41
42	9 225	5 195	**952 265**	7 084.8	1 470	79 074	3.965	42
43	10 011	5 638	957 903	8 239 1	1 711	80 785	4.000	43
44	9 639	5 428	963 331	8 492.0	1 762	82 547	3.984	44
45	8 983	5 059	968 390	8 462.0	1 755	84 302	3.953	45
46	7 823	4 406	973 796	7 862 1	1 631	85 933	3.893	46
47	7 225	4 069	976 865	7 745.2	1 607	87 540	3.859	47
48	7 396	4 165	981 030	8 438.8	1 750	89 290	3.869	48
49	5 766	3 247	984 277	6 994.2	1 451	**90 741**	3.761	49
50	5 774	3 252	987 529	7 436.9	1 543	92 284	3.761	50
51	4 464	2 514	990 043	6 097.8	1 265	93 549	3.650	51
52	3 502	1 972	992 065	5 067.4	1 051	94 600	3.541	52
53	3 085	1 737	993 752	4 723.1	980	**95 580**	3.489	53
54	2 374	1 337	995 089	3 843.5	797	96 377	3.375	54
55	1 957	1 102	996 191	3 346.5	694	97 071	3.293	55
56	1 591	896	997 087	2 870.2	595	97 666	3.202	56
57	1 276	719	997 806	2 425.7	503	98 169	3.106	57
58	1 048	590	998 396	2 098.1	435	98 604	3.020	58
59	728	410	998 806	1 533.2	318	98 922	2.862	59
60	667	376	999 182	1 476.7	304	99 226	2.824	60
61	429	242	999 424	997.9	207	99 433	2.632	61
62	334	188	999 612	815.3	169	99 602	2.524	62
63	240	135	999 747	616.4	128	99 730	2.380	63
64	183	103	999 850	491 0	102	99 832	2.262	64
65	96	54	999 904	269 8	56	99 888	1.982	65
66	62	35	999 939	182.3	38	99 926	1.792	66
67	40	22	999 961	123 0	25	99 951	1.602	67
68	30	17	999 978	96.4	20	99 971	1.477	68
69	23	13	999 991	77.2	16	99 987	1.362	69
70	16	9	1 000 000	56.1	12	99 999	1.204	70
76	1	0		4.5	1	100 000		76

Tab. XVI. English Market-Measurements.

Analysis by length and weight of all market-samples measured from the North Sea. Year III. October 1907—08.

Intervals of the 6 principal values in heavy type. Aver. length (*Al*) . . = 29.32 cm. Aver. weight (*Aw*) = 271.6 gm.

	Numbers			Calculated weight kg.			
	Absolute 1 597 468	Relative 1 000 000	Summation series	Absolute 433 883	Relative 100 000	Summation series	
cm							cm
16	14	9	9	0.6	0	0	16
17	159	100	109	8.6	2	2	17
18	2 423	1 517	1 626	152.7	35	37	18
19	10 573	6 619	8 245	782.4	180	217	19
20	33 023	20 672	28 917	2 840.0	656	873	20
21	65 294	40 873	69 790	6 464.1	1 450	2 323	21
22	101 839	63 750	**133 540**	11 610.0	2 678	5 001	22
23	124 818	78 135	211 675	16 226.3	3 742	8 743	23
24	144 903	90 708	**302 383**	21 300.7	4 911	**13 654**	24
25	149 701	93 711	396 094	24 850.4	5 730	19 384	25
26	131 791	82 500	478 594	24 513.1	5 652	25 036	26
27	116 803	73 118	*) **551 712**	24 295.0	5 602	**30 638**	27
28	107 598	67 355	619 067	24 855.1	5 729	36 367	28
29	98 051	61 379	680 446	25 199.1	5 810	42 177	29
30	91 296	57 150	737 596	25 928.1	5 978	48 155	30
31	74 515	46 646	**784 242**	23 323.2	5 378	*) **53 533**	31
32	71 564	44 798	829 040	24 546.5	5 659	59 192	32
33	45 639	28 570	857 610	17 160.3	3 953	63 145	33
34	44 127	27 623	885 233	18 136.2	4 182	67 327	34
35	32 781	20 521	**905 754**	14 653.1	3 379	70 706	35
36	20 053	12 553	918 307	9 745 8	2 248	72 954	36
37	16 967	10 621	928 928	8 941.6	2 053	75 007	37
38	14 823	9 279	938 207	8 463.9	1 952	**76 959**	38
39	10 839	6 785	944 992	6 676.8	1 540	78 499	39
40	9 129	5 715	**950 707**	6 070.6	1 400	79 899	40
41	7 059	4 419	955 126	5 047.2	1 164	81 063	41
42	7 185	4 498	959 624	5 517 1	1 273	82 336	42
43	6 914	4 328	963 952	5 690.2	1 312	83 648	43
44	7 103	4 446	968 398	6 257.7	1 443	85 091	44
45	7 184	4 497	972 895	6 767.3	1 561	86 652	45
46	6 047	3 785	976 680	6 077.2	1 402	88 054	46
47	5 907	3 698	980 378	6 332.3	1 460	89 514	47
48	5 768	3 611	983 989	6 581.3	1 518	**91 032**	48
49	4 694	2 938	986 927	5 693.8	1 313	92 345	49
50	4 759	2 979	989 906	6 129.6	1 414	93 759	50
51	3 312	2 073	991 979	4 524.2	1 044	94 803	51
52	2 679	1 677	993 656	3 876.5	894	**95 697**	52
53	2 158	1 351	995 007	3 303.9	762	96 459	53
54	1 815	1 136	996 143	2 938.5	678	97 137	54
55	1 461	915	997 058	2 498.3	577	97 714	55
56	1 055	660	997 718	1 903.2	440	98 154	56
57	838	525	998 243	1 593.0	368	98 522	57
58	734	459	998 702	1 469.5	340	98 862	58
59	518	324	999 026	1 090.9	252	99 114	59
60	479	300	999 326	1 060.5	245	99 359	60
61	307	192	999 518	714.1	165	99 524	61
62	235	147	999 665	573.6	132	99 656	62
63	148	93	999 758	378.9	87	99 743	63
64	123	77	999 835	330.0	76	99 819	64
65	105	66	999 901	295.0	68	99 887	65
66	56	35	999 936	164.7	38	99 925	66
67	40	25	999 961	123.0	28	99 953	67
68	30	19	999 980	96.4	22	99 975	68
69	16	10	999 990	53.7	12	99 987	69
70	10	6	999 996	35.0	8	99 995	70
71	6	4	1000 000	21.9	5	100 000	71

Tab. XVII. English Market-Measurements.

Analysis by length and weight of all market-samples measured from the North Sea. Years I—III. October 1905—08.

Intervals of the 6 principal values in heavy type. Aver. length (*Al*) . . = 28.08 cm. Aver. weight (*Aw*) = 255.4 gm.

	Numbers			Calculated weight kg.			
	Absolute 4 925 698	Relative 1 000 000	Summation series	Absolute 1 257 840	Relative 100 000	Summation series	
cm							cm
15	22	4	4	0.8	0	0	15
16	150	30	34	16.7	1	1	16
17	2 518	511	545	136.0	11	12	17
18	16 896	3 430	3 975	1 064.4	85	97	18
19	55 501	11 268	15 243	4 107.1	327	424	19
20	140 016	28 426	43 669	12 041.4	957	1 381	20
21	242 789	49 290	92 959	24 036.1	1 911	3 292	21
22	355 574	72 189	**165 148**	40 535.4	3 223	6 515	22
23	425 060	86 295	**251 443**	55 257.8	4 393	**10 908**	23
24	474 572	96 347	347 790	69 762.1	5 546	16 454	24
25	461 665	93 727	441 517	76 636.4	6 093	22 547	25
26	409 306	83 097	*) **524 614**	76 130.9	6 053	**28 600**	26
27	357 695	72 619	597 233	74 400.6	5 915	34 515	27
28	325 496	66 081	663 314	75 189.6	5 978	40 493	28
29	281 486	57 146	720 460	73 341.9	5 751	46 244	29
30	255 693	51 910	**772 370**	72 616.8	5 773	*) **52 017**	30
31	203 381	41 290	813 660	63 658.3	5 061	57 078	31
32	181 394	36 826	850 486	62 218.1	4 946	62 024	32
33	123 993	25 173	875 659	46 621.4	3 706	65 730	33
34	109 454	22 221	897 880	44 985.6	3 576	69 306	34
35	82 105	16 669	**914 549**	36 700.9	2 918	72 224	35
36	57 011	11 574	926 123	27 707.3	2 203	74 427	36
37	46 770	9 495	935 618	24 657.8	1 960	**76 387**	37
38	40 270	8 175	943 793	22 994 2	1 828	78 215	38
39	32 199	6 537	**950 330**	19 834.6	1 577	79 792	39
40	27 899	5 664	955 994	18 524.9	1 473	81 265	40
41	23 096	4 689	960 683	16 513.6	1 313	82 578	41
42	21 212	4 306	964 989	16 290 8	1 295	83 873	42
43	21 209	4 306	969 295	17 455.0	1 388	85 261	43
44	20 104	4 081	973 376	17 711.6	1 408	86 669	44
45	19 113	3 880	977 256	18 004.4	1 431	88 100	45
46	16 221	3 293	980 549	16 302.1	1 296	89 396	46
47	15 144	3 074	983 623	16 234.4	1 291	**90 687**	47
48	14 809	3 006	986 629	16 897.1	1 343	92 030	48
49	11 946	2 425	989 054	14 490.5	1 152	93 182	49
50	11 817	2 399	991 453	15 220.3	1 210	94 392	50
51	8 646	1 755	993 208	11 810.4	939	**95 331**	51
52	6 935	1 408	994 616	10 034.9	798	96 129	52
53	5 808	1 179	995 795	8 892.0	707	96 836	53
54	4 633	941	996 736	7 500.8	596	97 432	54
55	3 712	754	997 490	6 347.5	505	97 937	55
56	2 854	579	998 069	5 148.6	409	98 346	56
57	2 276	462	998 531	4 326.7	344	98 690	57
58	1 917	389	998 920	3 837.8	305	98 995	58
59	1 346	273	999 193	2 834.7	225	99 220	59
60	1 229	250	999 443	2 721.0	216	99 436	60
61	800	162	999 605	1 860.8	148	99 584	61
62	615	125	999 730	1 501.2	119	99 703	62
63	426	86	999 816	1 090 6	87	99 790	63
64	333	67	999 883	893.4	71	99 861	64
65	215	44	999 927	604.1	48	99 909	65
66	135	27	999 954	397.0	32	99 941	66
67	91	18	999 972	279.8	22	99 963	67
68	67	14	999 986	215.3	17	99 980	68
69	41	8	999 994	137.6	11	99 991	69
70	26	5	999 999	92.1	7	99 998	70
71	6	1	1 000 000	21.9	2	100 000	71
76	1	0.2	1 000 000	4.5	0	100 000	76

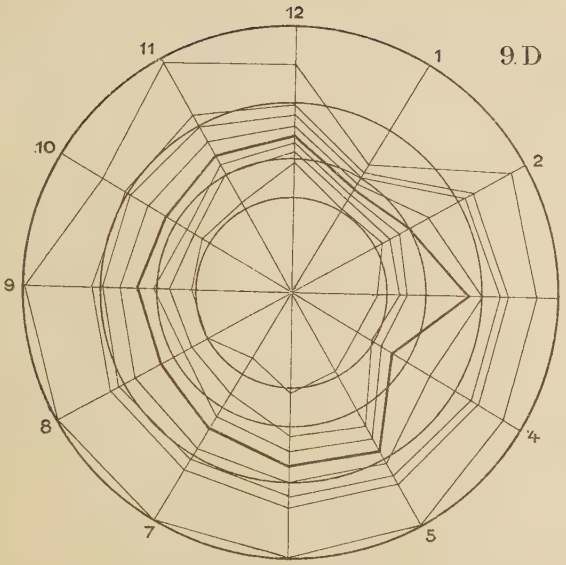
Plate I.

Plate I.

English Market-Measurements 1905—08.

Cyclic representation of the monthly landings from the different areas of the North Sea.

Each circle refers to the area indicated by the letter annexed. The radii numbered 1 to 12 in each circle are the ordinates of the corresponding months January to December; on each of the radii, starting from the centre of the circle, the following principal values of the monthly series have been marked off (on the scale of 1/20; see scale below on the left); lower extreme (E), lower decile (D), lower quartile (Q), central value or median (M), upper quartile (Q), upper decile (D), upper vigintile (V), upper extreme (E). The points of equal value, e. g. all the median values of the 12 months, are connected by lines; the line through the median values is represented thicker than the others. The three concentric circles at respectively 25, 35 and 50 indicate the 25, 35 and 50 cm. points on the radii. The more the concentric lines (with exception of the extremes) approach the periphery of the circle, the greater are the corresponding principal values of the measurement series and the greater also is the average length of the plaice in the landings belonging to the radius (month) concerned.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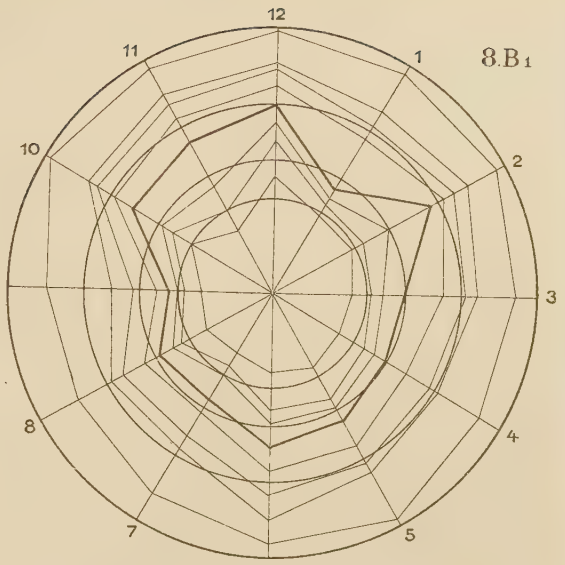
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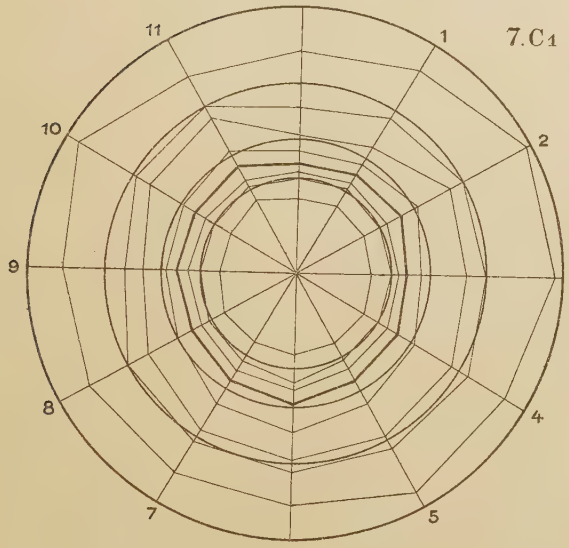
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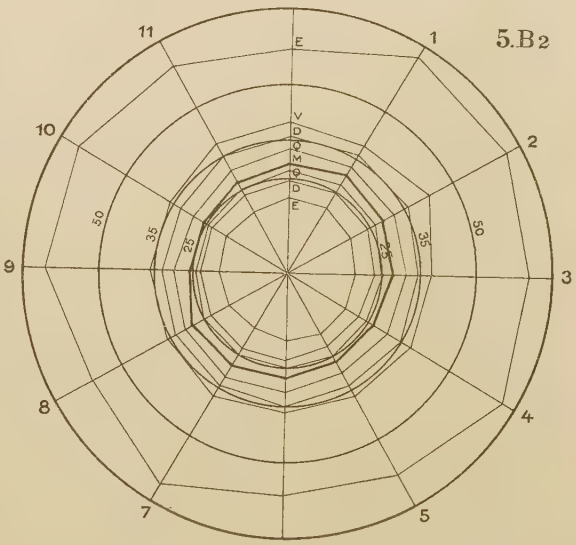
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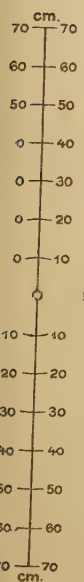
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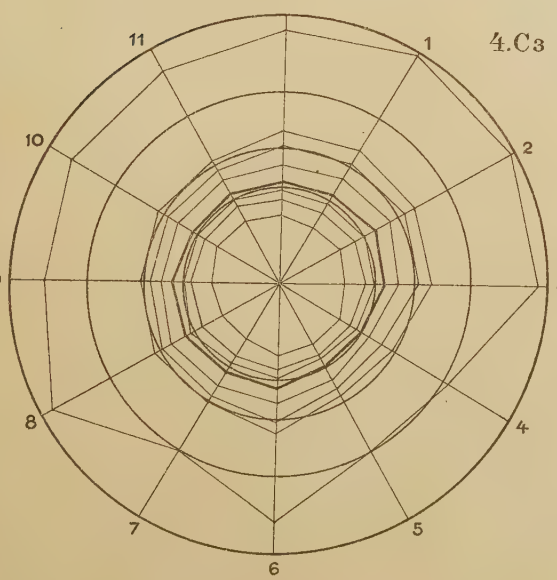
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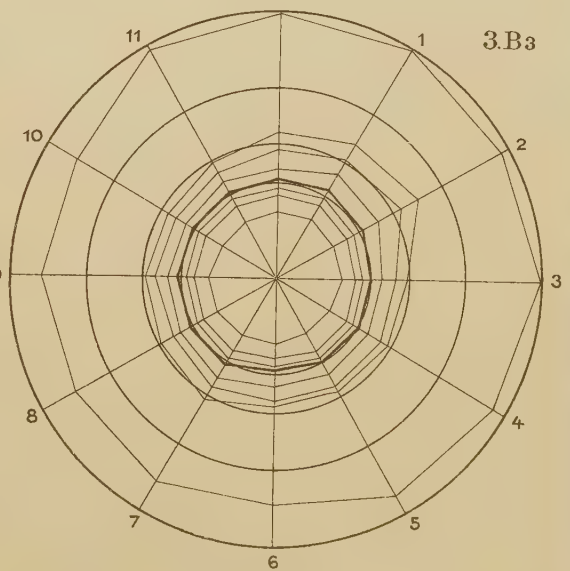
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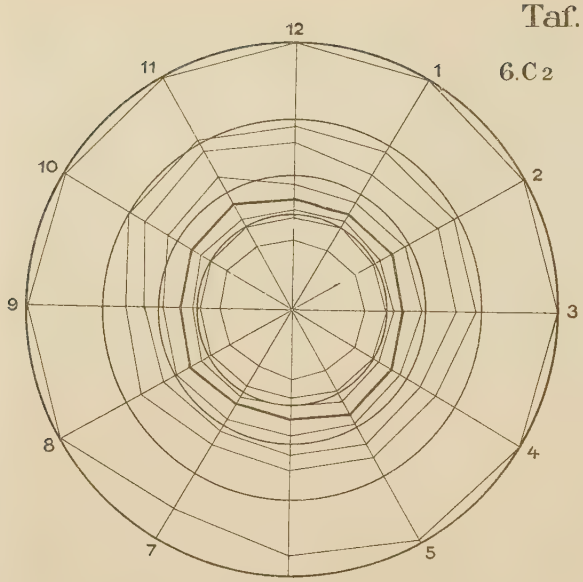
4
5
6
7
8
9
10
11

Taf. I.



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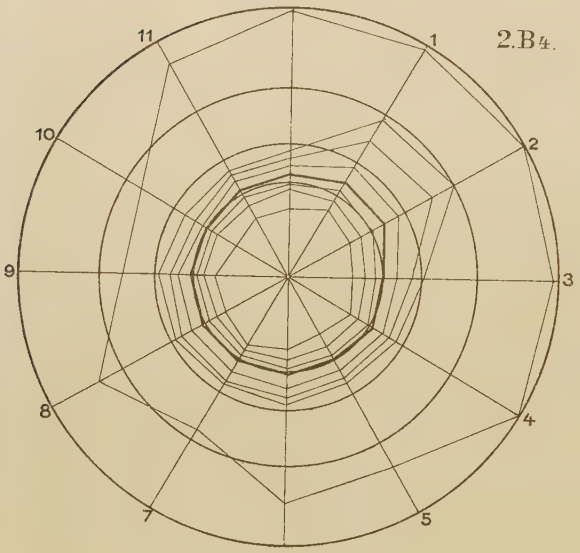

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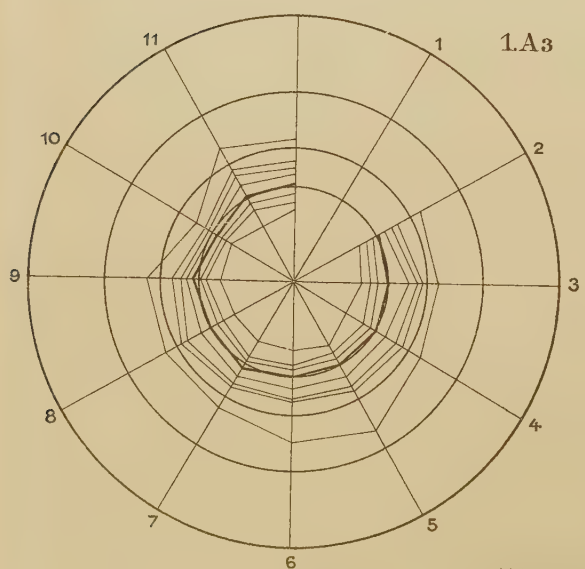


1.A 3

A.E. F. AAMODT KJØBENHAVN

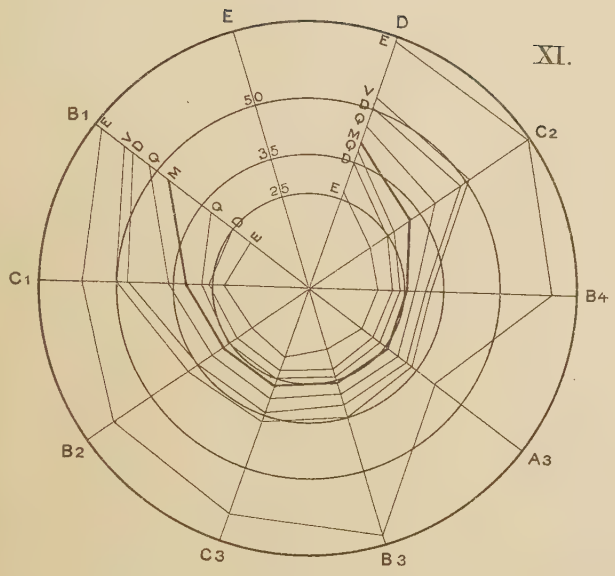
Plate II.

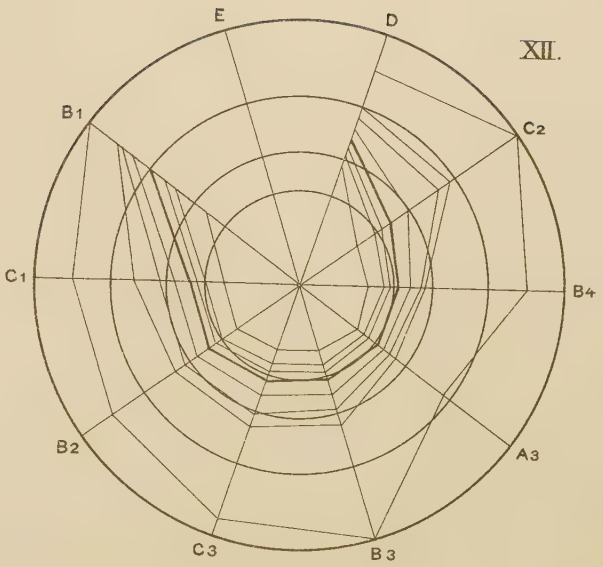
Plate II.

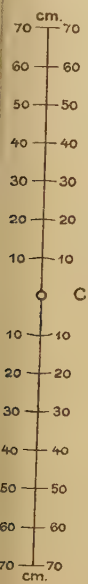
English Market-Measurements 1905—08.

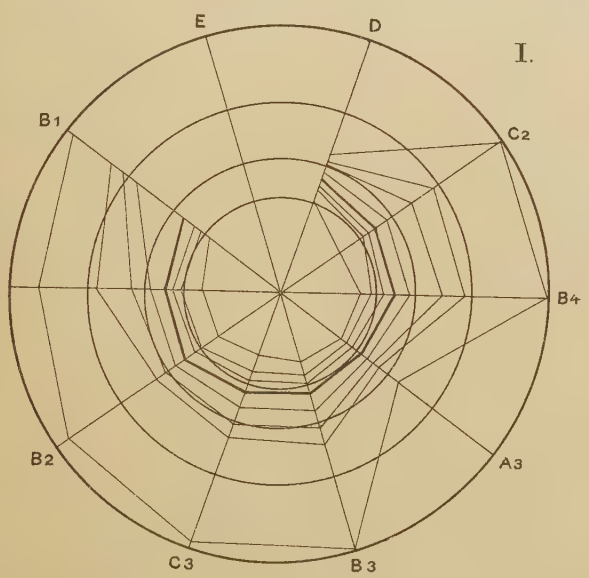
Cyclic representation of the composition
of the landings from the different areas of the North Sea, arranged according to months.
Winter months: XI, XII, I, II; November, December, January, February.

Each circle here represents the whole North Sea in a certain month. The radii represent the different areas as indicated by the letters; they are so arranged, that the northern areas lie in the upper half, the southern areas in the lower half of the circle. Along each radius from the centre of the circle are marked off the principal values of the measurement series for the area and the month concerned, and the points of the same denomination on the radii are joined together as in Pl. I. For area E there are no measurements from the winter months.


XI.
E
D
B1
C2
C1
B4
B2
A3
C3
B3
50
35
25


XII.
E
D
B1
C2
C1
B4
B2
A3
C3
B3


cm.
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
cm.


I.
E
D
B1
C2
C1
B4
B2
A3
C3
B3

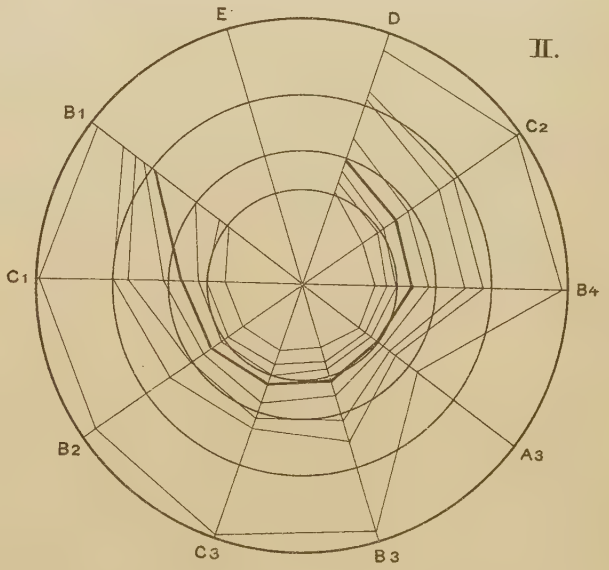

II.
E
D
B1
C2
C1
B4
B2
A3
C3
B3

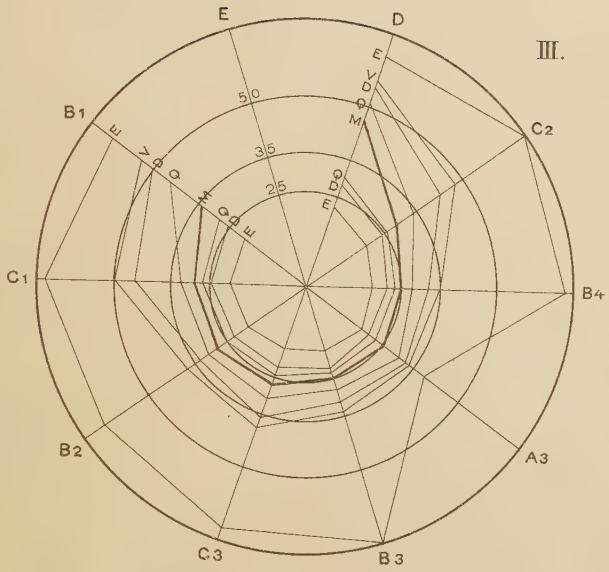
Plate III.

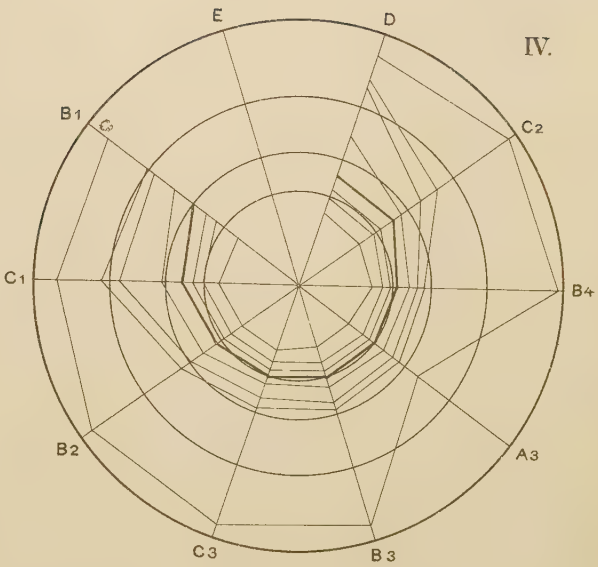
Plate III.

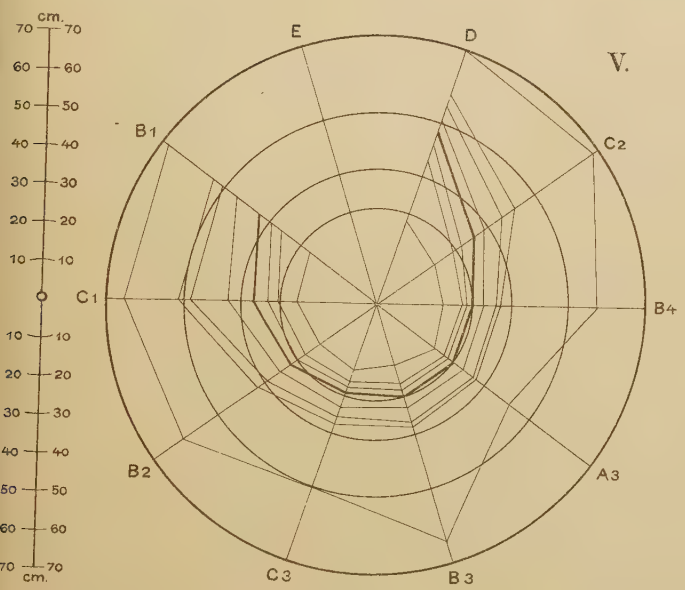
English Market-Measurements 1905—08.

Cyclic representation of the composition
of the landings from the different areas of the North Sea, arranged according to months.
Spring months: III, IV, V, VI; March, April, May, June.

Each circle here represents the whole North Sea in a certain month. The radii represent the different areas as indicated by the letters; they are so arranged, that the northern areas lie in the upper half, the southern areas in the lower half of the circle. Along each radius from the centre of the circle are marked off the principal values of the measurement series for the area and the month concerned, and the points of the same denomination on the radii are joined together as in Pl. I. For area E there are no measurements from the winter months.


III.
E
D
B1
C2
C1
B4
B2
A3
C3
B3
50
35
25


IV.
E
D
B1
C2
C1
B4
B2
A3
C3
B3


V.
cm.
70
60
50
40
30
20
10
0
E
D
B1
C2
C1
B4
B2
A3
C3
B3

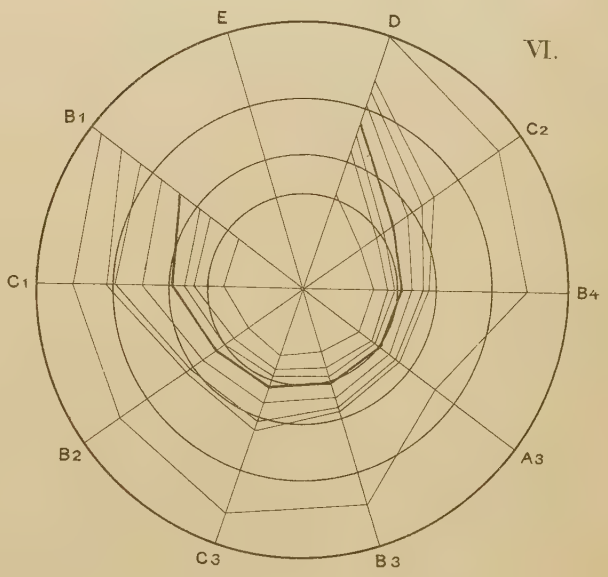

VI.
E
D
B1
C2
C1
B4
B2
A3
C3
B3

Plate IV.

Plate IV.

Cyclic representation of the composition
of the landings from the different areas of the North Sea, arranged according to months.
Summer months: VII, VIII, IX, X; July, August, September, October.

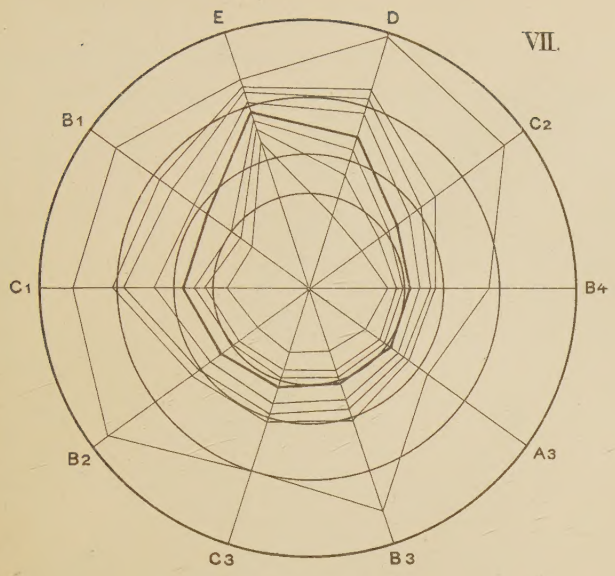
XIII. Landings from the areas for the year.

XIV. Monthly landings from the whole North Sea.

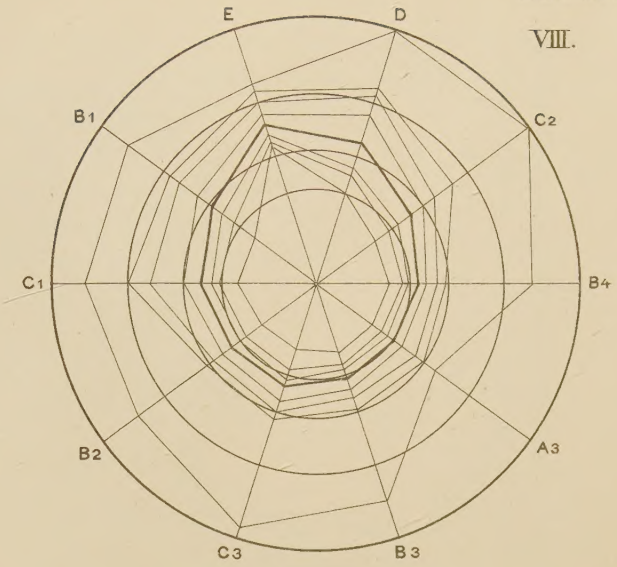
Each circle here represents the whole North Sea in a certain month. The radii represent the different areas as indicated by the letters; they are so arranged, that the northern areas lie in the upper half, the southern areas in the lower half of the circle. Along each radius from the centre of the circle are marked off the principal values of the measurement series for the area and the month concerned, and the points of the same denomination on the radii are joined together as in Pl. I. For area E there are no measurements from the winter months.

In fig. 13 the circle represents the whole North Sea and the radii indicate the separate areas with the principal values of the areal measurement series for the whole year marked on them. In fig. 14 the circle represents the whole North Sea and the radii indicate the separate months with the principal values of the monthly measurement series for the whole North Sea marked on them.

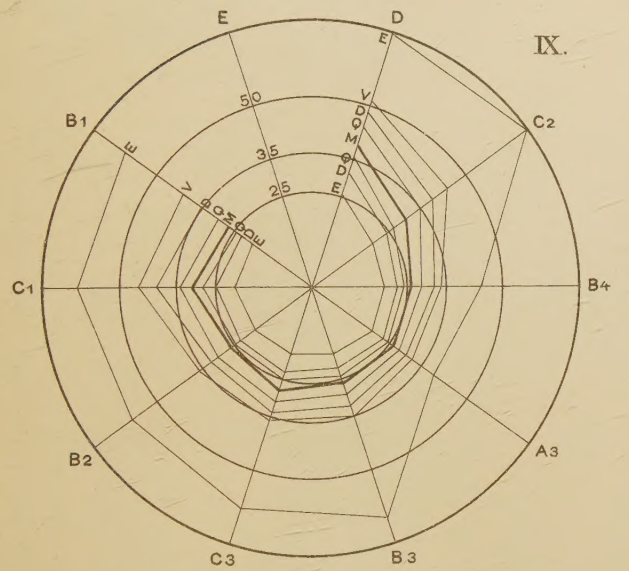
VII.



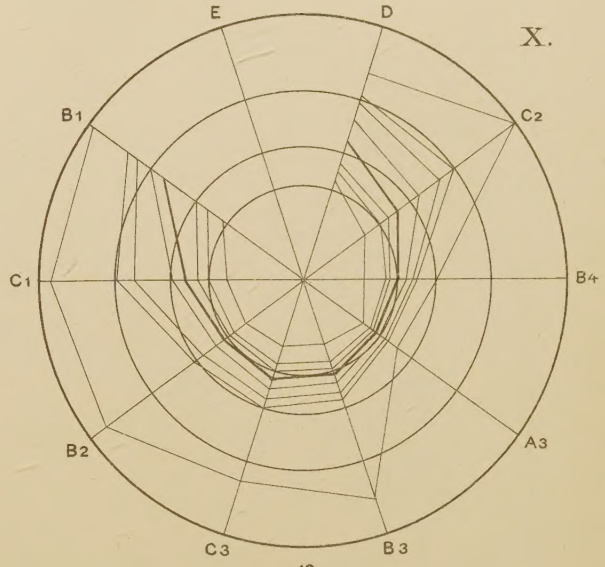
VIII.

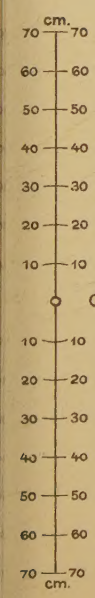


IX.



X.





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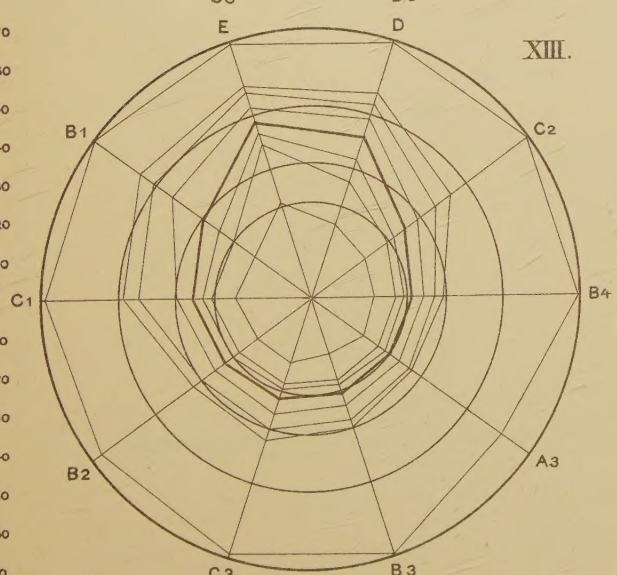

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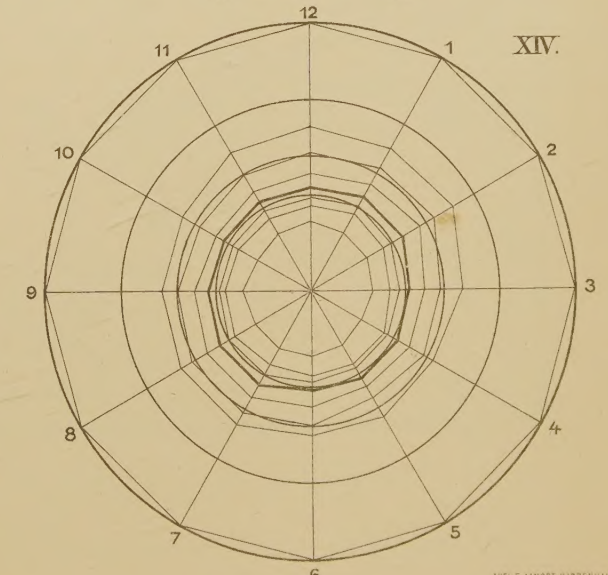

AXEL E. AAMODT, KJØBENHAVN

Subdivision of the North Sea into Areas (Plaice fishing grounds).

Depth of the areas:

A 0—20 m.; B 20—40 m ; C 40—60 m.; D 60—80 m.; E 80—100 m.; F 100—200 m.; G over 200 m.